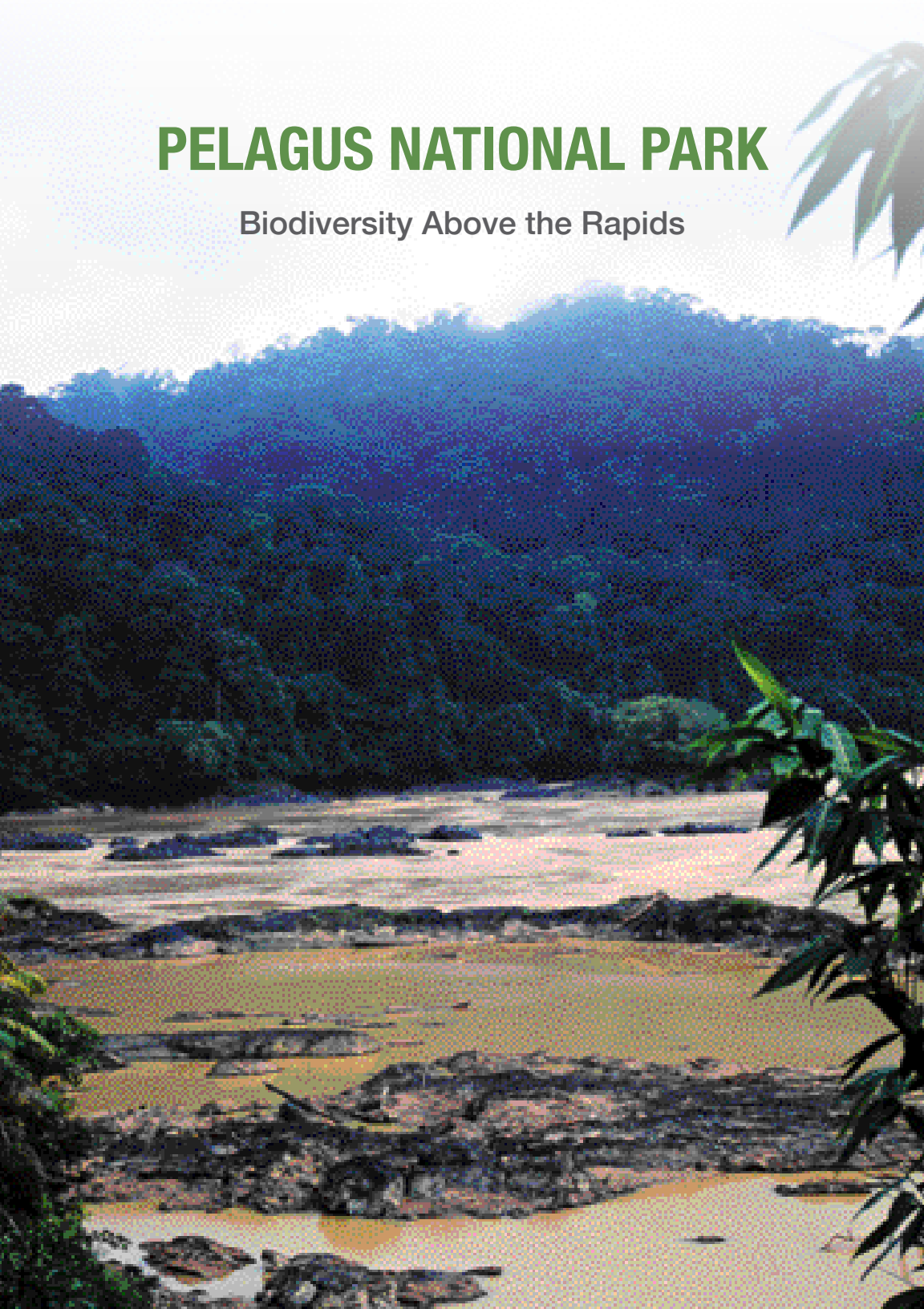
PELAGUS NATIONAL PARK

Biodiversity Above the Rapids



Life from Headwaters to the Coast

PELAGUS NATIONAL PARK

Biodiversity Above the Rapids

Edited by

Andrew Alek Tuen, Indraneil Das
Karen Lee Suan Ping and Jayasilan Mohd-Azlan

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Andrew Alek Tuen, Indraneil Das, Karen Lee Suan Ping and Jayasilan Mohd-Azlan

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Half-title page: The Rapids of Pelagus, as seen in August 2003. Photo: I. Das
Frontispiece: *Megophrys nasuta*, the Bornean Horned Frog. Photo: Pui Yong Min
Foreword page and across: Aerial view of Pelagus Kaki Wong. Photo: Tonny Ganyai.

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CONTENTS

FOREWORD

Prof. Datuk Dr. Mohamad Kadim Suaidi
Vice Chancellor, Universiti Malaysia Sarawak

Since its humble beginnings in 1992, Sarawak's first public university, Universiti Malaysia Sarawak (UNIMAS), has put natural resource management and biodiversity conservation at the forefront of its research agenda. This includes the setting up of the Faculty of Resource Science and Technology and the Institute of Biodiversity and Environmental Conservation. The location of UNIMAS on the island of Borneo has given us a unique opportunity to study its biodiversity, one of the most diverse in the world. Over the years, university researchers have discovered new species and uncovered new facets of the biology of numerous threatened species and landscapes, contributing to the conservation of species and habitats in Sarawak and beyond.

To be globally relevant and forward looking, UNIMAS has established linkages and collaborated with like-minded individuals and institutions within Malaysia and overseas. On 24 September 2013, we formalised a research collaboration with Sarawak Energy, to embark on the first in-depth study of the 2,041-hectare Pelagus National Park. As a result of this collaboration, significant new findings have come to light and have been featured in this book.

I would like to congratulate the authors, editors and publishers for their hard work and perseverance, to help unravel the wonders of biodiversity of Pelagus, and make this place of magic and mystery accessible to the world.

MESSAGE

Datu Haji Sharbini Suhaili
Group Chief Executive Officer, Sarawak Energy Berhad

Congratulations to all those who are part of this important publication. Your contribution will enhance knowledge and understanding of Sarawak's biodiversity areas in general and the Pelagus National Park in particular.

In mid-2020, it was announced by the Sarawak government that Sarawak will become a high-income economy by 2030 through the two core principles of a digital economy and environmental sustainability, and Sarawak Energy is fully aligned to this vision.

We are developing our energy resources sustainably to deliver greater access to affordable, reliable and sustainable energy for Sarawak and its people, in alignment with Goal #7 of the United Nations Sustainable Development Goals (SDG) 2030.

Just over a decade ago, Sarawak made a strategic decision to reduce our dependence on thermal resources of coal, gas and diesel through the Sarawak Corridor of Renewable Energy.

As a result, Sarawak Energy is now the largest renewable energy developer and provider in Malaysia through our investments in large renewable hydropower as well as solar and micro-hydro for remote areas.

As a member of the International Hydropower Association, we are a strong advocate of sustainable hydropower and are working to integrate a robust sustainability agenda into our business. It is estimated that less than 2% of our land area will be affected when we fully harness our hydropower potential to ensure a sustainable energy future for our state and beyond.

To conserve biodiversity in line with SDG #15, we are working with various state agencies, higher learning institutions, local communities and stakeholder groups on efforts to mitigate any negative impact and maximise the positive impact of our projects and operations.

Initiatives include the implementation of sustainable management of forest types which are important water catchments. We also contribute to

the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services. Our partnerships so far have yielded encouraging successes.

1. The Batang Ai National Park and catchment area, located within the area of the 35-year-old Batang Ai Hydroelectric Plant (HEP), serve as a buffer zone that supports the regeneration of the surrounding environment. The area is now home to a sustainable population of the Bornean orangutan in Sarawak and forms part of the transboundary conservation area with Indonesia's Betung Kerihun National Park.
2. For the Murum HEP project, the Wildlife Monitoring and Rescue (WiMoR) operation with the Sarawak Forestry Corporation rescued and relocated wildlife in significant numbers to safer areas before impoundment.

To ensure we understand the effectiveness of our efforts, research and development is an important part of our business. This creates greater understanding of the impact of our projects by enhancing the body of knowledge and enables us to make informed decisions in environmental management and conservation.

In 2013, we partnered with Universiti Malaysia Sarawak (UNIMAS) and rolled out the Hydropower Environmental Sustainability Programme with a focus on three objectives:

i. To identify critical local environmental issues that warrant closer attention;
ii. Collect necessary data in forming baseline knowledge particularly in the areas of aquatic and terrestrial ecology and biodiversity; and
iii. Support the development of local research capability and capacity within Sarawak on related environmental topics.

The 2,041-hectare Pelagus National Park was identified as one of the study locations under this programme given its importance as a protected area. Significant findings have been established and are featured in this book.

We are pleased to support this book publication together with Universiti Malaysia Sarawak (UNIMAS) in line with SDG #17 which calls for multi-stakeholder partnerships that mobilise shared knowledge, expertise, technology and financial resources.

On behalf of Sarawak Energy, I would like to thank UNIMAS for this research collaboration and for sharing your expertise and resources.

We are also fortunate to have collaborated with and gauged the support from like-minded organisations such as our higher learning institutions, Forest Department Sarawak and Sarawak Forestry Corporation in enabling Sarawak Energy to play a greater role in local environmental conservation efforts.

I would also like to congratulate Sarawak Energy's Research and Development team. I am confident that you have gained valuable experience and further exposure through this research as part of Sarawak Energy's hydropower development journey.

PREFACE

Andrew Alek Tuen, Indraneil Das,
Karen Lee Suan Ping* and *Jayasilan Mohd-Azlan

Sarawak's vast protected areas network, including its National Parks, are home to many of the State's natural wonders- floral, faunal, geological and at the level of landscapes. Central Sarawak, in particular, is an important area for biodiversity conservation, being home to uncountable Bornean endemics.

Its thriving National Parks vindicate the commitment of the State Government as a responsible caretaker of Sarawak's biodiversity. Halting biodiversity loss is one of the top State agendas, whereby Sarawak is determined to conserve and protect its wildlife and natural ecosystem. This project sits in line with the University's niche area of biodiversity and environmental conservation. This book, based on extensive field research by the staff of our two organisations, brings together new information on species, their habitats and other aspects of natural history.

Little has been written about Pelagus National Park. Scientific understanding of biodiversity intended for conservation is crucial for our advancement to preserve the State's natural heritage. Identifying the distribution, richness and habitat use of animals in tropical rainforest are essential for understanding their ecology, and in facilitating management of such biodiversity-rich areas. This book attempts to enumerate selected zoological groups, many of which had hitherto remained undetected in these dense tropical rainforests. The faunal studies reported here include inventories of mammals, birds, reptiles, amphibians, fishes and macroinvertebrates, a critical first step towards understanding the biodiversity of Pelagus National Park.

The work targets local stakeholders, management authorities, naturalists, researchers and the general public. Most enthusiasts continue to see protected areas as a parade of natural wonders, to be appreciated and protected for future generations. An understanding of our biodiversity may thus support complex needs of conservation. It is hoped that nature enthusiasts and those who are interested in tropical biodiversity will find this book beneficial. Acknowledgement is here made to the authors who have gathered these data, substantially increasing our knowledge and awareness of an important part of our national heritage.

Foremost, we thank Sarawak Energy Hydropower Environmental Sustainability Program for a research grant to conduct the activities mentioned in this work. We are grateful to the Resident of Kapit Division for welcoming us to the area under his jurisdiction, and to the longhouse folks from Rumah John at Nanga Benin (John anak Asun and family), Rumah Bujah at Nanga Pelagus (Bujah anak Ijau and family) and Rumah Laja at Nanga Peraran (Laja anak Sandak and family), for assisting with the research.

Prof. Dr. Wan Hashim bin Wan Ibrahim, the Deputy Vice Chancellor for Research and Innovation, Prof. Dr. Lo May Chiun and her staff at the Research Innovation and Enterprise Centre facilitated the research on the UNIMAS side. We also thank the staff of the Institute of Biodiversity and Environmental Conservation, and the Faculty of Resource Science and Technology, UNIMAS, for logistic and field assistance: Isa Sait, Rahah Mohd. Yakup, Mohd. Hasri Al-Hafiz Haba, Ketty Daun, Pasey Lisus, Mohsin bin Zainalabidin, Siti Maimunah binti Ibrahim and Felicia Reyap, besides our many research assistants and graduate research students.

The Sarawak Forest Department provided research permits for the individual projects reported here. Entry to Pelagus Resort area was provided by Pelita Holdings Sdn. Bhd, and we thank its manager, Netty Haji Narawi. We thank Mohd. Tajuddin Abdullah, Qammil Muzzammil Abdullah, Amirruddin Ahmed, Faisal Ali Anwar Ali, Aaron M. Bauer, Henry Bernard, Chan Kin Onn, Stuart James Davies, Ulmar Grafe, Suhaila binti Abdul Hamid, Kelvin Lim, Lo May Chiun, Suhaili Mokhtar, Mustafa Abdul Rahman, Abdullah Samat and Tan Heok Hui for reviews of the chapters, and Genevieve V. A. Gee for copy editing. We are thankful to Chien C. Lee for images of birds, Faisal Ali Anwar Ali for the images of bats and to the family of the late Brian Houldershaw for the images of the Rapids from the 1960s, made possible through the kindness of Albert Field.

We dedicate this book to the kind-hearted folks of the Rajang Basin, who offered us their homes and carried the burden and joy of discovery.

INTRODUCTION

Andrew Alek Tuen, Indraneil Das,
Karen Lee Suan Ping* and *Jayasilan Mohd-Azlan

The Pelagus area is located in the heart of Sarawak, along the mid-reach of the Rajang River. It is about 126 km long, and approximately five hours upstream from the city of Sibu. Pelagus National Park was gazetted in the year 2009, under Sarawak's National Park and Nature Reserve Ordinance, 1998, and covers an area of approximately 2,041 ha. Although unmanned, entry to the National Park requires permission from the Sarawak Forestry Corporation.

Areas under primary forest cover have rapidly dwindled in the State, with remnant patches widely dispersed and isolated, and rarely identified and protected, such as this. The Park consists of pristine and old secondary forests, the latter being remnants of patches that witnessed logging activities in the early 1960s. While biodiversity has declined in all modified tropical forests, those that were selectively logged have been able to sustain substantial biodiversity, especially in older regrowth forests. Due to its relatively unspoiled condition, a holiday resort was established near the Park. However, the Regency Pelagus Resort ceased operations in 2012 and what remains are the ruins now occupied by bugs and bats using the once grand structure, set within a rainforest.

The rare visitor to the Pelagus site will be greeted by the calls of gibbons and hornbills, advertising for mates, early in the morning, with fog and mist covering the rapids and forests. These are not unusual experiences in the tropical rainforest of Borneo, but at Pelagus, the flavour appears heightened. The abandoned Resort facing the Rapids holds many tragedies with numerous boats crashed by the jagged rocks protruding from the Rajang, and perhaps untold number of casualties. Legend holds that these rocks were formed by a mythological creature that was killed by an Iban warrior, and members of the local communities perform rituals and offerings to the Rapids to this day.

The Iban community around Pelagus predates the establishment of the National Park and have been dependent on its resources for hundreds of years. There are several longhouses near Pelagus National Park (including Rumah John, Rumah Bujah, Rumah George, and Rumah Laja). Collection of non-timber forest produce, such as Rattan and non-protected wildlife (i.e., Bearded Pig, *Sus barbatus*, Sambar Deer, *Rusa unicolor*, Muntjac, *Muntiacus* sp., Mouse-deer, *Tragulus* sp.) are relatively common here. These anthropogenic

impacts may affect species richness, distribution and activity pattern of many mammals, especially those that are heavily hunted. The Bearded Pig is one of the most sought after in Kapit, and is often associated with variation of aggregation strategies, ranging from solitary to mass aggregation and wide range migration. They have been observed crossing the river near Pelagus as part of mass migration, when certain local communities are involved in the hunt.

Besides depending on forest produce and freshwater fish, the local communities are engaged in cultivation. Areas near these longhouses are mostly planted with crops such as rice, vegetable and fruit-bearing trees (i.e., *Durio* spp., *Canarium odontophyllum*, *Capsicum* spp., *Zea* spp., *Manihot esculenta* and *Sauropus androgynus*). Sufficient areas for agriculture and appropriate hunting regulation in Pelagus are important to reduce the pressure on wildlife dependency and for maintaining high levels of biodiversity in the surrounding areas. It is important to make an assessment of the remnant biodiversity and the current conservation needs, which, in turn, dictates conservation action.

The chapters in this book comprise findings from a project that brings together the expertise of specialists and is expected to provide vital information of the natural heritage of a biologically rich area in Sarawak to stakeholders, management authorities, naturalists, researchers and for the general public.

HISTORY

Oswald Braken Tisen **and** ***Rambli Ahmad***

The idea of Pelagus National Park (PNP) was first mooted in the 1960s. R.E Tremeer, the Agricultural Officer for Third Division, on 23 October 1964, wrote an official memorandum to the Director of Agriculture for Soil Survey, which was forwarded to the Conservator of Forest:

> "The Third Divisional Development Committee has endorsed a proposal to constitute a National Park at Pelagus. I have been asked to indicate any areas distant from the rapids which are suitable for agricultural development and which should therefore be excluded from the National Park.
>
> To the best of my knowledge, the terrain in the vicinity of the Rapids is unsuitable for agriculture. However, I would be very grateful if the Soil Survey Branch could, based on aerial photographs and any other existing information, suggest tentative boundaries for the Park."

Fig. 1. An Iban struggles to haul the longboat through the Pelagus Rapids situated on the Sungai Rajang between Kapit and Belaga. Sarawak. Aug/Sep 1964. Photo: Brian Houldershaw.

In 1966, a memorandum from Section Forest Officer to Conservator of Forest recommended Sg. Angkawat as part of the inland boundary for the proposed PNP and include the Bukit Wong near Sg. Lebau. The area of interest was part of the Pelagus Protected Forest, established in 1934, during which time there existed only two longhouses.

The terrain of the area is low and undulating, with steep, narrow and deep valleys. The highest point is Bukit Wong, which has an altitude of about 325 m above sea level.

The Sarawak Government Gazette, dated 4 October 1973 (No 2741), mentioned that on 17 July 1973, the Governor in Council declared his intention of constituting an area, 5,110 acres in extent, as the Pelagus Rapids National Parks. Consequently, the Resident of Seventh Division, on 20 December 1973, put up a notification for claim of any right in or over any land within the area proposed as a National Park.

In the undated "A Proposal to Establish Pelagus National Park" by National Park and Wildlife Office of the Forest Department Sarawak, it was mentioned that the proposal to establish the National Park was abandoned due to the intention to develop the Pelagus Hydro-Electric Power Project in 1979. As such, the area of interest was licensed out for timber extraction. During the Fifth Malaysia Plan (1986 to 1990), the Pelagus National Park proposal was revived to create more such Parks in the country. Sarawak has decided to set aside at least 10 per cent of its land area as 'Totally Protected Areas' (TPAs), which include national parks, nature reserves or wildlife sanctuaries.

The proposal mentioned that the aims of establishing the Pelagus National Park were to conserve forest land to protect a forested environment for sustained recreational use for both local and foreign visitors; to help boost tourism in Sarawak; to conserve wildlife, particularly protected species; and to protect vegetation surrounding the Pelagus Rapids. It was mentioned that wild boars, deer and Rhinoceros hornbills could still be seen in the area while fishes were abundant in significant quantity near the "Kaki Wong", especially during the dry season. Several vegetation types were recognised including the riparian and riverine forests, mixed dipterocarp forests, the old secondary forests, the cliff vegetation and shrubs. A rare shrub species, *Didesmandra aspera* belonging to the Dilleniaceae family was found to occur only in this area.

In the proposal, the Pelagus Rapids or 'Wong Pelagus' was thought to be a popular place for picnickers and tourists, not only to view the rapids, but some to experience the rapids themselves.

"The fascinating beauty of the Pelagus Rapids is no exaggeration. During low water, interesting rocks of many shapes emerge from the belly of Batang

Fig. 2. The going gets tough as Kenyan, the master boatman, sets his course through this particular stretch of the Pelagus Rapids. Aug/Sep 1964. Photo: Brian Houldershaw.

Fig. 3. The crew from the other longboat are also doing their best to get Kumbong's boat through this part of the Pelagus rapids. Sungai Rajang, Sarawak. Aug/Sep 1964. Photo: Brian Houldershaw.

Fig. 4. An Iban struggles to haul the longboat through the Pelagus Rapids situated on the Sungai Rajang between Kapit and Belaga, Sarawak. Aug/Sep 1964. Photo: Brian Houldershaw.

Fig. 5. At this point in the Pelagus Rapids, the water level is very low and the Iban crew of the longboat have their work cut out dragging the craft through the shallows. Sungai Rajang, Sarawak. Aug/Sep 1964. Photo: Brian Houldershaw.

Rajang which adds to the beautification of the scenery. The drop of the rapids can be seen clearly. Sounds of water beating against the rocks and riverbanks creating the rhythmic melodies – the music of Wong Pelagus. During high water, the water flows fast and whirls around like whirlpools. This phenomenon can be sighted from the scenic view-point constructed alongside these rapids."

Pelagus National Park was established on 26 February 2009 through the Sarawak Government Gazette dated 2 July 2009. It covers an area of approximately 2,041 ha of the southern end of the Pelagus Protected Forest, stretching from Sungai Angkawat as the inland boundary including Bukit Wong, near Sungai Lebau right to the true right bank of Batang Rajang.

Pelagus National Park has several unique features that make the area suitable for nature walks, such as the scenic rapids, as well as several endemic Bornean species of plants and animals. The visit to Pelagus can be a component of a larger programme to the Rajang. Promoting unusual as well as endemic species may perhaps encourage people to participate in nature walks.

Tourism and recreation tend to be centred around activities. A well-planned itinerary and knowing the needs of customers allow their expectations to be met or exceeded.

The attraction of the area can be focussed on Culture, Adventure, and Nature (CAN) tourism. It can be designed to promote the natural environment of the area, incorporating adventure, utilising the natural features that form the landscape. Tourism beyond the Park can showcase the culture and way of life of the local communities, the Iban and Punan Bah at their respective longhouses, located between Pelagus and Belaga, where unique burial poles can be an added attraction. The adventure begins when one starts the journey going upriver of the mighty Rajang River.

The Pelagus Regency Resort, which is now closed, at its height, was a 40 room, Iban longhouse-style resort, designed with a Sarawak motif. It was located on the left bank of the Rajang, upstream of the first rapid. The design, siting, construction, colour and decoration of the resort blended harmoniously with the natural surroundings, which gave it a sense of being one with nature. The view of the rapids from the resort was stunning and the sound of the water was relaxing. A joy ride along the famous Pelagus Rapids would excite any visitor. A large longboat could ferry up to four passengers for a 20 to 30 minutes ride up or down the rapids.

The Pelagus National Park is the only place between Kapit and Belaga with substantial forest cover. A trek is a rewarding and relaxing activity that can be enjoyed by visitors of all levels of fitness. It enables one to take an interest in natural history and to experience the tropical rainforest. Users of the trails can partake in various activities such as bird watching and botany.

The Kaki Wong – Pala Wong Trail, which meanders along the bank of the Batang Rajang, is especially scenic.

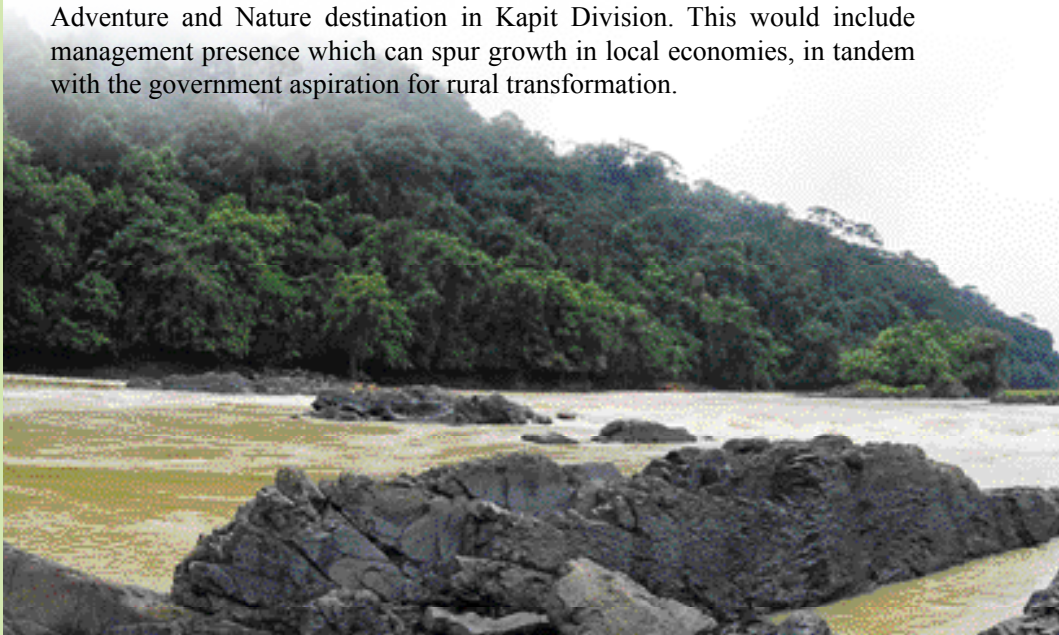
The rapids present a great opportunity for further adventures, such as kayaking and rafting, an experience of a lifetime amidst the lush tropical rainforest, an encounter with exotic wildlife and interactions with indigenous tribes. Pelagus is thus ideal for niche tourism, based on culture, adventure and nature.

There was a discussion between Sarawak Forestry Corporation and Land Consolidation Development Authority for the Pelagus Regency Resort to be converted as the Park headquarters in 2004. However, it took five years for the area to be gazetted as a national park thus the interest to make use of the Pelagus Regency Resort was left forgotten.

Upon gazettement in 2009, it was managed as an unmanned National Park, under the purview of the Sarawak Forest Department, where the focus is ensuring that the Park is protected.

Pelagus National Park is the only protected area easily accessible from Kapit. The park would answer the call by the state government that all cities and towns must have a natural area to serve as a green lung and provide a recreational site for locals.

The State government has made a recent policy change that Totally Protected Areas (TPAs) and biodiversity conservation are placed under the authority of Sarawak Forestry Corporation – Parks and Wildlife (SFC). SFC has plans to open up more TPAs, which are strategically located and has a high potential for tourism within the Twelfth Malaysian Plan (2021–2025). Pelagus National Park meets these criteria to be developed as a prime Culture, Adventure and Nature destination in Kapit Division. This would include management presence which can spur growth in local economies, in tandem with the government aspiration for rural transformation.



THE PELAGUS GHOST

Andrew Alek Tuen

Located on the upper reaches of the mighty Rajang River, the Pelagus Rapids conjures a scene of fast and furious waters that dip and swirl between huge boulders and rocky outcrops. Only skilled and experienced boatmen dare to navigate them, a dangerous endeavour that elicits both fear and excitement, but had to be undertaken nevertheless because this is the only way to reach Belaga from Kapit and vice-versa. It is a difficult and dangerous journey when the water level is high and impassable for 'Tongkang' and express boats during low water levels. In the process, countless lives have been lost, earning the nickname "Rapids of Death".

The rapids, however, present a great opportunity for adventure, an experience of a lifetime amidst the lush tropical rainforests, an encounter with exotic wildlife and indigenous tribes. At the same time, it offers a form of niche tourism based on Culture, Adventure and Nature (CAN), which has been promoted globally in the aftermaths of the Rio Earth Summit, and to which local investors and government alike simply could not resist the temptation to cash in.

And so it was. A six million Malaysian Ringgit (RM), three-star hotel, the Regency Pelagus Resort, constructed by the banks of the mighty Rajang, near Kaki Wong (Figs 1–2), about an hour speedboat ride upriver from Kapit town. This resort was meant to provide alternative income to the local people through participation in ecotourism related activities, and therefore not engage in logging, hunting or clearing land for hill paddy, as well as to stem mass migration of able-bodied men into towns and cities.

Modelled on traditional Iban longhouses, with "bilik" and "ruai", it was constructed almost entirely from wood, the floor raised from the ground, complete with local arts and motifs.

The Regency was officially opened in August 1994 by the then Chief Minister of Sarawak, Datuk Patinggi Tan Sri Dr Haji Abdul Taib bin Mahmud, and given a 3-star rating by the Ministry of Tourism in 2008. Room rates were high — RM 418 per pax per night for an air-con room and RM 398 for a non-aircon room, and beyond the reach of most local tourists.

Tourism packages included visits to longhouses as well as night and day walks in the forests. However, these packages did not include the experience of a lifetime — shooting the rapids. Perhaps the management did not want to

Fig. 1. Aerial views of the Rajang River. Photo: Tonny Ganyai.

Fig. 2. Aerial views of the Regency Pelagus Resort. Photo: Tonny Ganyai.

take the risk of losing their already meagre customers through drowning in the rapids, and insurance premium for such an activity would be prohibitive. But then again, for the adventure-seeking tourists, insurance premiums / the adrenaline, fear and excitement of a longboat ride through the "Rapids of Death" would be a story worth telling for generations. Unfortunately, it was simply missing from the itinerary.

The Regency finally ceased operation in October 2010 and officially closed in January 2012 (Fig 3.), but signs of impending collapse were showing much earlier. Local tourists seldom came because it did not appeal to them and rooms were priced beyond their reach. In every aspect, the Regency was meant for foreign tourists.

So what does the future hold for this million-ringgit investment that is slowly and surely falling apart? The local politicians have, in the recent past, mentioned about reopening the Pelagus Resort. There is a future for niche tourism in Pelagus, perhaps by a local who is both a believer and entrepreneur, someone with a personal touch and passion for what Pelagus has to offer. Or perhaps as a gateway to Pelagus National Park?

Fig. 3. View of the abandoned Pelagus Regency Resort corridor, as seen in July 2014.

GEOLOGY AND VEGETATION

Hans Hazebroek

Pelagus National Park, with an area of 2,041 hectares, is located along the Pelagus Rapids, around the midsection of Batang Rajang, about 170 km upstream from Sarawak's second largest city of Sibu. It was gazetted as a National Park on 26 February 2009.

The Rajang is the longest river in Sarawak, originating from the Iran Mountains, in the central highlands at the border with Indonesia, and traversing northwestwards, and then westwards for about 565 km, before emptying into the South China Sea. Historically, the rapids of Pelagus have been a barrier to upriver travel, protecting the Kayan tribesmen of the upper reaches of the river from raids by head-hunting Iban parties.

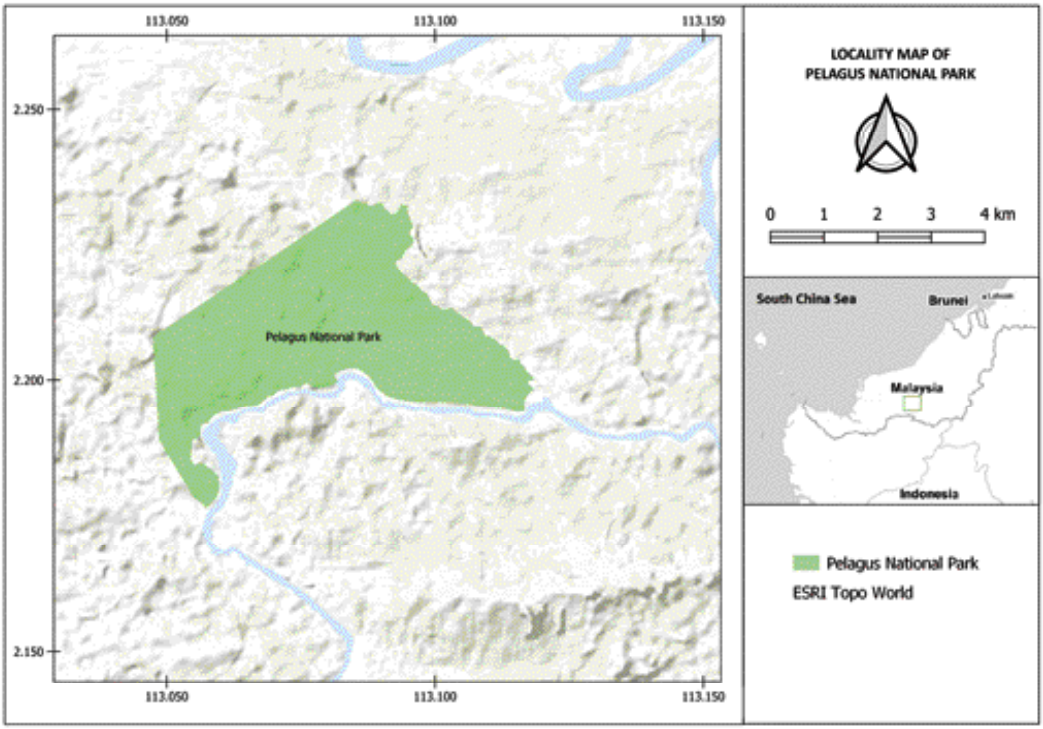


Fig. 1. Map showing the location of Pelagus National Park, located along the Rajang River of Sarawak State, East Malaysia, on the island of Borneo.

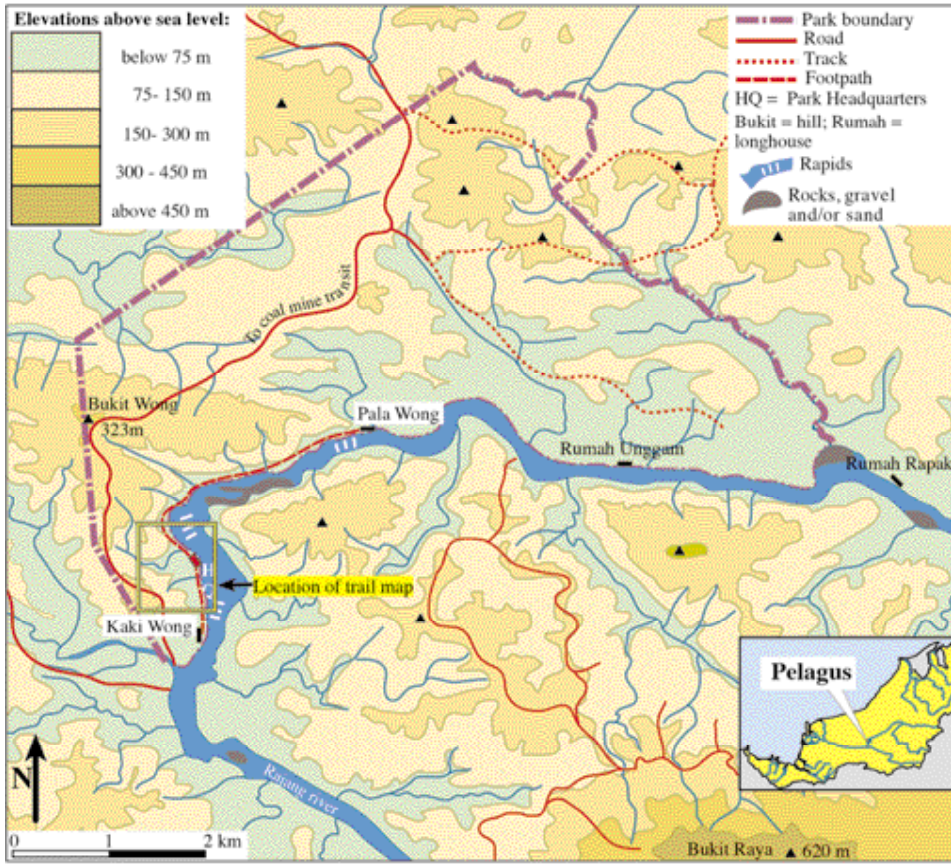


Fig. 2. Topographic map of Pelagus National Park, showing boundaries, trails and other features.

Here, on the banks of the river, overlooking the rapids, a private resort, the Regency Pelagus Resort opened to tourists at the beginning of the century. Built in the style of an Iban wooden longhouse, proved difficult to maintain, and ceased operation in 2010. The boundaries of the Park start at the edge of this desolate resort, leading modern-day ecotourists to several trails and streams.

The geology of the area is worthy of comment, the highlight of Pelagus being the rapids. The rocks that underlie the area are altered shales and sandstones of the Belaga Formation. The hard sandstone layers being more resistant to weathering than the shales, form prominent ridges and hills that constitute the landscape, including the rapids. Sand, initially deposited in a

Fig. 3. (a) Tree buttresses are home to the herbs of the family Gesneriaceae. (b) A clear stream within the Pelagus National Park.

Fig. 4. (a) Remnants of 55 to 40 million year old sandstone layers in the bed of a small stream. (b) The deep scarlet split fruit capsules of *Sterculia* treelet appears to attract birds, that disperse the seeds. (c) *Etlingera*, a genus of gingers, blooming on the forest floor.

deep-sea environment as a result of underwater avalanches, was subsequently consolidated due to deep burial, and converted into sandstones, and uplifted and exposed due to plate tectonic movements. To reduce the number of accidents on account of the rapids, most of the rocks were blasted around 10 years ago, further reducing the scenic views once enjoyed from the banks of the Park.

The vegetation of the Park is predominantly lowland mixed dipterocarp forests, alternating with stretches of secondary forests; on ridge crests, they demonstrate regeneration following forestry intervention. Plant diversity along the Park's trails is rich, the highlight being giant hardwood trees. Two trails make the Park accessible to the ecotourist — the Nature Trail, which begins at the former resort and forms a loop, initially heading up a nearby ridge with a height of about 120 m above the river. The Pelagus Rapids Trail begins at the site of the former resort and winds its way through the rainforest and along the river, covering 2.2 km. It shows several steep sections, including two rope-assisted descents into rocky stream beds. The trail is 3.4 km and follows the bank of the Rajang river, and has about 40 small side-streams that can be negotiated with care by now disintegrating ironwood bridges. The trail extends from Kaki Wong at the foot of Pelagus Rapids to Pala Wong at the point that once coincided with the head of the rapids.

Interestingly, this particular trail was built by locals to permit boat passengers to bypass the dangers of the rapids while their boats performed their struggle. A visit to the Pelagus area therefore gives visitors an idea what the vast areas in the interior of the Rajang Basin were like, up to the middle of the last century.

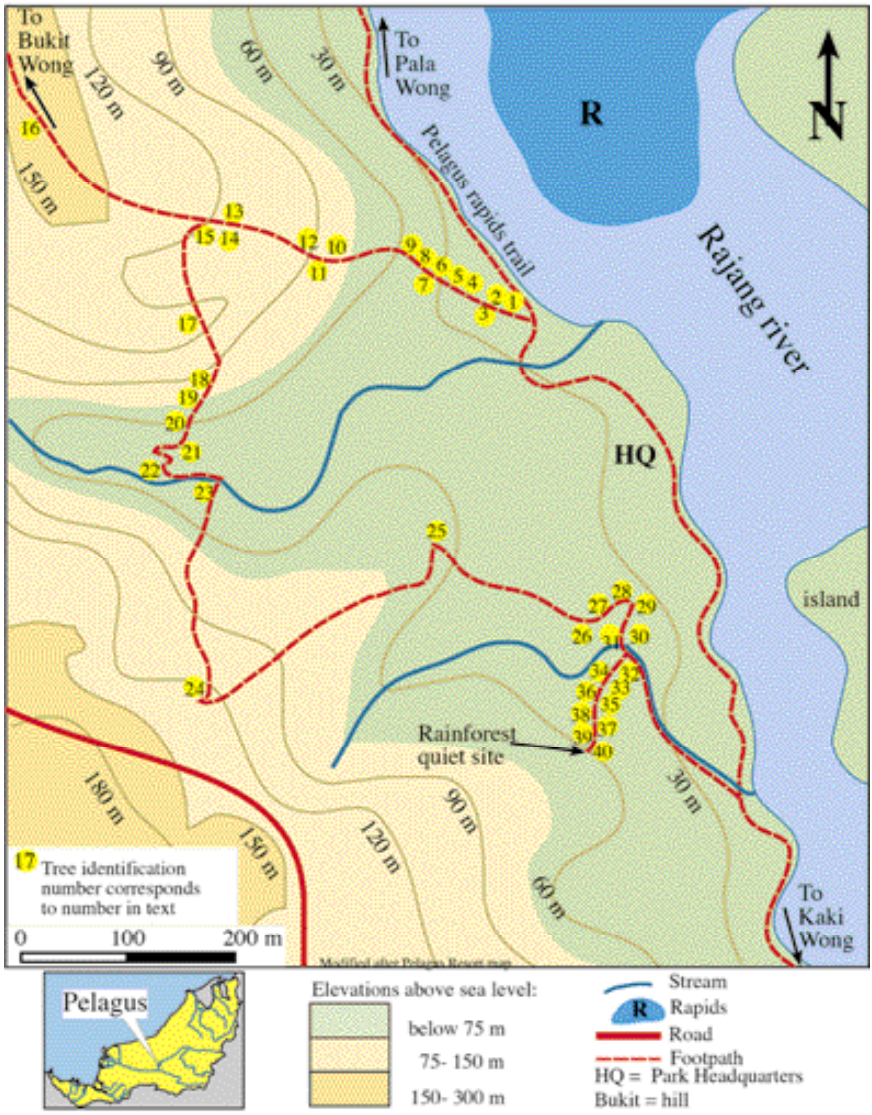


Fig. 5. Nature trails within the Pelagus National Park.

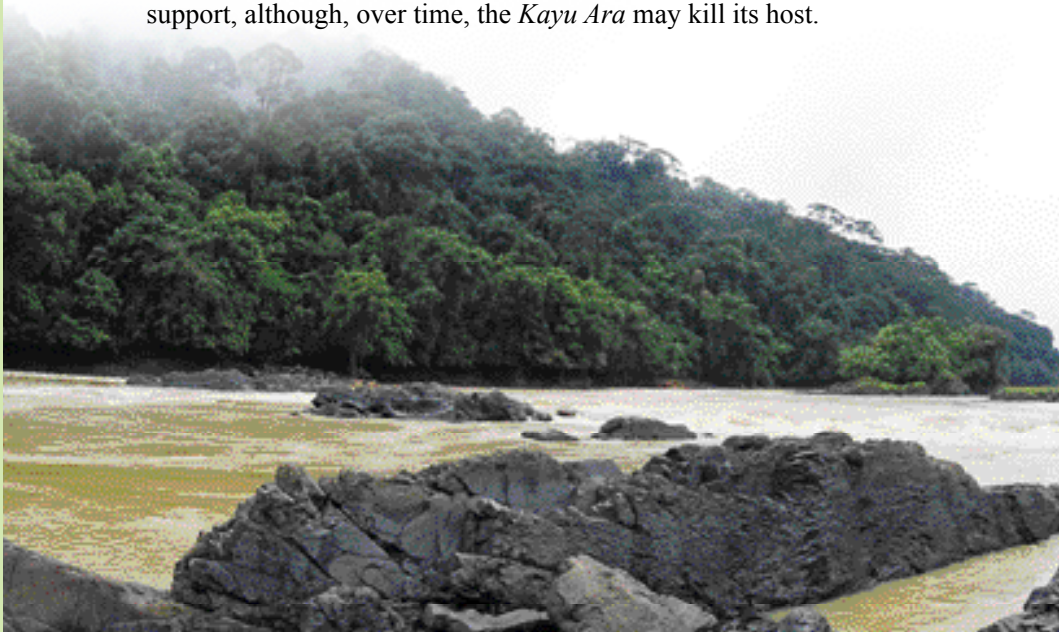
Major tree species encountered along the trail are enumerated here. Numbers refer to figure above.

1. *Merecapan* (*Blumeodendron* sp.) - A member of the rubber tree family. Several *Salacca* palms, with feather-shaped fronds, can be seen near the tree.
2. *Ubah Jurup* (*Syzygium* sp.) - Shows distinctive peeling bark, that give it a shaggy appearance. Nearby, one can see *Licuala* and *Salacca* palms.
3. *Tegera* (Family Meliaceae) - The flowers grow directly from the trunk (known as cauliflory), an adaptation to encourage pollination by large birds and mammals. Nearby, one can see *Calamus* rattan, in demand for the manufacture of cane furniture.
4. *Kayu Hujan* (Family Theaceae) - Literally, "rain tree", as the wood is wet when the tree is cut.
5. *Ubah Kelabu* (*Syzygium* sp.) - Many species are fruit trees, providing nutrition for forest animals and people. Fruits of several trees are known locally as *Jambu*.
6. *Pala Munsoh* (*Artocarpus* sp.) - The genus includes many fruit trees, the breadfruit and jackfruit being probably the best known. The bark of some species are used to make bark cloth and cord.
7. *Nyalin* (*Xanthophyllum* sp.) - A distinctive tree, with yellow wood and a thorny trunk. Fruits of some are used as substitute for pepper; bark and roots have medicinal properties.
8. *Pelai* (*Alstonia* sp.) - A soft-wood tree, used for carving. The latex and leaves are used to treat smallpox, boils, shingles and even centipede bites.
9. *Jerentik* (*Baccaurea* sp.) - An important genus of fruit trees that provides resources for frugivores, as evident from squirrel scratches frequently seen on the tree trunks. This tree has small, reddish fruit.
10. *Meranti Lop* (*Shorea* sp.) - This is a large genus of hardwood and semi-hardwood trees, belonging to the family of dipterocarps (Dipterocarpaceae). Nearby is a palm with numerous long, black spines on the stem, this is *Nibong* (*Oncosperma tigillarium*). The wood of the palm is used in the construction of floors and walls of longhouses and jetties. Behind the *Meranti* is a *Keranji* (*Dialium* sp.), the fruits of which resemble small eggs and their soft, velvety pulp is edible.
11. *Kelampai* (*Elateriospermum tapos*) - A tree used for making poles to pound rice by indigenous communities, and the leaves are also eaten. On the bark of the tree, scratch marks of a Sun Bear can be seen.

12. *Mengris* (*Koompassia malaccensis*) - Similar to the *Tapang* tree, this too grows to a large size and displays dark, hard wood which can be polished. The wood is in demand for making blowpipes.
13. *Dillenia* sp. (Family Dilleniaceae) - *Dillenia* leaves are in demand for wrapping food.
14. *Prawan Engkajang* (*Shorea* sp.) - A semi-hardwood species of dipterocarp, and an important timber species, which is hollow inside.
15. *Parashorea parvifolia* (Family Dipterocarpaceae) - The Iban name for this tree is *Urat Mata Bukit,* in reference to its rounded roots and to the fact that it is found on hills.
16. *Keladan* (*Dryobalanops* sp.) - These are the famous Borneo camphor trees which, in addition, have valuable timber.
17. *Kayu Hujan* (Family Theaceae), see no. 4. - The lower trunk of this tree is marked by the tusks of a bearded pig. There are several large wild *sago* palms close by, recognisable by their large, feathery fronds implanted on a short, stout stem.
18. *Meranti Lop,* see no. 10.
19. *Kumpang* (*Knema* sp.) - A tree of the nutmeg family. The wood is often used for firewood.
20. *Meranti Lop*; As in location no. 10. several *Nibong* palms (*Oncosperma tigillarium*) grow near the *Shorea*.
21. From this point onwards, there are several Nibong palms visible from the trail. See No. 10 for details.
22. At this point, the trail reaches the stream.
23. The trail now leaves the stream and follows a ridge upwards to an old logging road.
24. *Belian* (*Eusideroxylon* sp.) - The famous Ironwood Tree, its wood in demand for making poles that support houses, jetties and bridges, and is also used in carvings.
25. *Kayu Massam* (*Aporosa* sp.) - This tree stands at the junction of two old logging roads. The trail between points 25 and 26 passes through an area of forest regeneration. The tall, thin and smooth trunks of the pioneer tree species are evident, many of which show large, three-lobed leaves, that characterise *Macaranga*.
26. *Ubah Semut* (*Syzygium* sp.) - A tree that is hollow and houses ants. The red trees, with spreading branches on either side are *Kayu Hujan* (Family Theaceae), see no. 4.
27. *Meranti Lop*, see no. 10.

Fig. 6. Lianas or woody climbers, as illustrated by this individual in flower, characterise Sarawak's lowland forests. Their fruits are important resources for many birds and mammals.

28. *Mengris,* see no. 12. - This point offers a good view of a valley, dominated by *Licuala* palm, showing fan-shaped fronds and pandanus or screwpines, with the leaves arranged in a spiral.
29. *Jerentik,* see no. 9.
30. *Muang Cali* (*Shorea venulosa*) - Another member of the dipterocarp family.
31. At this point, the trail reaches and follows a stream, and subsequently heads uphill towards a rest point at a stand of *Koompassia* and *Shorea* trees.
32. The trail leaves the stream here and heads towards a stand of majestic *Koompassia* sp. and *Shorea* sp. trees.
33. *Melebu* (*Sterculia* sp.) - A small member of the cacao family. Some have scarlet flowers.
34. *Tapang* (*Koompassia excelsa*) - One of the tallest, the newly measured Seraya kuning siput (*Shorea faguetiana*) at Danum Valley is now the tallest at 100.8 m. The lofty branches often bear bee hives, and local people climb these heights to collect honey.
35. *Mengris,* see no. 12.
36. *Meranti* (*Shorea* sp.) - A dipterocarp species valued for its red wood.
37. *Mengris,* see no. 12. - Near to this tree is a strangling fig tree, recognisable by the basket-like network of roots.
38. *Lingkat* (Family Malvaceae) - A local *Durian.*
39. *Kumpang* (*Knema* sp.) - A member of the nutmeg family with dark red sap.
40. *Kayu Ara* (*Ficus* sp.) - A strangling fig which uses a host tree as support, although, over time, the *Kayu Ara* may kill its host.



MACROINVERTEBRATES

Jongkar Grinang, Brian Haessler Delim, Lee Nyanti, Teck-Yee Ling, Siong-Fong Sim, Tonny Ganyai* and *Karen Lee Suan Ping

The drainage system of the Pelagus area comprises first to sixth order streams, with slow to fast flowing water and moderate gradient channels. The tributaries are important feeder streams in sustaining hydrological functions of the main Rajang River, especially as a result of the construction of two hydroelectric dams in the upper stream, the Bakun Dam and Murum Dam.

Macroinvertebrates sampling was conducted twice at 27 tributaries between 2013 and 2016. Three replicates of kick-net sampler (30 × 32 cm, 400-micron mesh size) were made for each visit, yielding a total of 162 samples. Hand collecting at night along riverbanks and forest trails was carried out for semiterrestrial crabs. Specimens caught from local fishing tools, such as castnet ('jala') and traps ('bubu') were also recorded. The multiple sampling techniques used have produced a macroinvertebrate inventory for the Pelagus area, which shows over 79 species in 52 families and 12 orders, comprising aquatic insects, crustaceans, molluscans and aquatic worms. All crabs and some taxa of aquatic insects are endemic to Borneo. Macroinvertebrates were assigned to functional feeding groups, and field observations of species occurrence on major substrate types were recorded.

Analysis of functional feeding groups shows that predators and gathering-collectors are common in all stream orders. Macroinvertebrates are well represented in third order streams, which imply that the stream order is the most productive. High beta diversity (dissimilarity) between lower order stream (1st order) and higher orders (> 3rd order) suggests that conservation management of river basin should be inclusive in all stream orders. Macroinvertebrates are good indicator for stream condition in the Pelagus area. Low taxa richness of sensitive orders such as Ephemeroptera, Plecoptera and Trichoptera (EPT) may indicate that effects of logging activities persist after 30 years. EPT-values also show low adaptation to new and unstable substrates originating from the logged catchment area.

Some larger species, such as shrimps, prawns (e.g., *Macrobrachium rosenbergii*), snails and crabs are important sources of protein for the local people.

Fig. 1. Geomorphological features of river systems in the Pelagus area, showing that the substrates are new and unstable, originating from the logged catchment area. (a) 1st order stream, Sg. Preran Mit; (b) 3rd order stream, Sg. Buya; (c) 5th order stream, Sg. Sama; (d) macroinvertebrate sampling.

Table 1. Streams sampled at the Pelagus region and the geographical coordinates.

Stream/order	Coordinates	Stream/order	Coordinates
Sg. Amang/2nd order	113.06214°E 2.17458°N	Sg. Lebau/3rd order	113.09391°E 2.19306°N
Sg. Beluli/2nd order	113.08227°E 2.14826°N	Sg. Ensawie/4th order	113.09364°E 2.25170°N
Sg. Senyamok/2nd order	113.07238°E 2.16102°N	Sg. Sebingol/4th order	113.08325°E 2.19797°N
Sg. Sap/3rd order	113.06472°E 2.16408°N	Sg. Serau/4th order	113.09391°E 2.19306°E
Sg. Benin/3rd order	113.07344°E 2.16480°N	Sg. Sama/5th order	113.16602°E 2.26629°N
Sg. Raya/4th order	113.08778°E 2.15193°N	Sg. Pangau Kecil/1st order	113.5090°E 2.47619°N
Sg. Nguan/4th order	113.04612°E 2.17892°N	Sg. Mia/2nd order	113.37469°E 2.38230 N
Sg. Mejau/4th order	113.04945°E 2.17615°N	Sg. Pangau Besar/2nd order	113.50418°E 2.46814°N
Sg. Kapit Ulu/5th order	113.07381°E 2.13777°N	Sg. Mikai/3rd order	113.30665°E 2.3469°N
Sg. Mella/5th order	113.08595°E 2.13233°N	Sg. Sangaya/3rd order	113.34744°E 2.37779°N
Sg. Serian/2nd order	113.13624°E 2.19265°N	Sg. Benatu/3rd order	113.38378°E 2.39877°E
Sg. Buya/3rd order	113.12754°E 2.24911°N	Sg. Bon/3rd order	113.46943°E 2.44425°N
Sg. Rarai/3rd order	113.14646°E 2.22040°N	Sg. Lahanan/4th order	113.44247°E 2.42856°N
Sg. Preran Mit/3rd order	113.12221°E 2.19025°N		

Fig. 2. Example of taxa from the Pelagus area. (a) Whirligig beetle, *Porrhorrhynchus marginatus*; (b) Water strider, *Ptilomera* sp.; (c) Stonefly family, Perlidae; (d) Larva of fishfly, *Protothermes* sp.; (e) giant freshwater prawn, *Macrobrachium rosenbergii*; (f) male *Ibanum* aff. *bicristatum*; (g) *Bakousa* cf. *kenepai*; (h) *Arachnothelphusa* sp. inside a tree-hole. Images are not to scale. Taxonomic investigations of the three crab species are currently ongoing.

A Checklist of Macroinvertebrates

Macroinvertebrates with their functional feeding groups. *endemic to Borneo.

Taxon	Functional Feeding Groups
ANNELIDA	
Haplotaxida (aquatic worms)	
Lumbricidae	Scraper
MOLLUSCA	
Gastropoda (snails)	
Buccinidae	
Clea nigricans A. Adams, 1885	Scraper
Pachychilidae	
Sulcospira pageli (Thiele, 1908)	Scraper
Pomatiopsidae	
Robertsiella sp. (1 morphospecies)	Scraper
MALACOSTRACA	
Decapoda (crabs and shrimps)	
Gecarcinucidae	
Arachnothelphusa cf. *merarapensis**	Shredder
Bakousa cf. *kenepai**	Shredder
Potamidae	
Ibanum aff. *bicristatum**	Shredder
Isolapotamon nimboni Ng, 1987*	Shredder
Palaemonidae	
Macrobrachium callirrhoe (De Man, 1898)	Shredder
Macrobrachium rosenbergii De Man, 1879	Shredder
Isopoda (sowbugs)	
Cirolanidae	
Anopsilana sp. (1 morphospecies)	Shredder
INSECTA	
Odonata (damselflies and dragonflies)	
Chlorocyphidae	
Libellago cf. *hyalina**	Predator
Coenagrionidae	
Pericnemis sp. (1 morphospecies)	Predator
Euphaeidae	
Euphaea aff. *subcostalis**	Predator
Lestidae	

Taxon	Functional Feeding Groups
Orolestes cf. *wallacei*	Predator
Platycnemididae	
Copera sp. (1 morphospecies)	Predator
Platystictidae	
Drepanosticta sp. (1 morphospecies)	Predator
Aeshnidae	
Indaeschna cf. *grubaueri*	Predator
Heliaeschna sp. (1 morphospecies)	Predator
Chlorogomphidae	
Chlorogomphus cf. *dyax**	Predator
Corduliidae	
Epophthalmia sp. (1 morphospecies)	Predator
Macromia cf. *westwoodii*	Predator
Gomphidae	
Heliogomphus sp. (1 morphospecies)	Predator
Ictinogomphus decoratus (Selys, 1854)	Predator
Megalogomphus sp. (1 morphospecies)	Predator
Sieboldius japponicus (Selys, 1854)	Predator
Libellulidae	
Crocothermis servilia (Drury, 1773)	Predator
Ephemeroptera (mayflies)	
Baetidae	
Baetis spp. (2 morphospecies)	Gathering-Collector
Platybaetis sp. (1 morphospecies)	Gathering-Collector
Caenidae	
Caenis sp. (1 morphospecies)	Gathering-Collector
Euthyplocidae	
Polyplocia sp. (1 morphospecies)	Gathering-Collector
Heptageniidae	
Campsoneuria sp. (1 morphospecies)	Scraper
Epeorus sp. (1 morphospecies)	Scraper
Thalerosphyrus sp. (1 morphospecies)	Scraper
Isonychiidae	
Isonychia sp. (1 morphospecies)	Gathering-Collector
Leptophlebiidae	
Choroterpes sp. (1 morphospecies)	Gathering-Collector
Habrophlebiodes sp. (1 morphospecies)	Gathering-Collector

Taxon	Functional Feeding Groups
Thraulus sp. (1 morphospecies)	Gathering-Collector
Potamanthidae	
Pothamantus sp. (1 morphospecies)	Gathering-Collector
Rheonanthus sp. (1 morphospecies)	Gathering-Collector
Tricorythidae	
Tricorythus sp. (1 morphospecies)	Gathering-Collector
Plecoptera (stoneflies)	
Nemouridae	
Amphinemura sp. (1 morphospecies)	Predator
Perlidae	
Phanoperla spp. (2 morphospecies)	Predator
Trichoptera (caddisflies)	
Hydropsychidae	
Hydropsyche sp. (1 morphospecies)	Filtering-Collector
Macrostenum sp. (1 morphospecies)	Filtering-Collector
Philopotamidae	
Dolophilodes sp. (1 morphospecies)	Filtering-Collector
Hemiptera (aquatic bugs)	
Gerridae	
Esakia sp. (1 morphospecies)	Predator
Rhagadotarsus sp. (1 morphospecies)	Predator
Rheumatogonus sp. (1 morphospecies)	Predator
Ptilomera spp. (2 morphospecies)	Predator
Nepidae	
Cercometus asiaticus (Amyot and Serville, 1843)	Predator
Veliidae	
Pseudovelia sp. (1 morphospecies)	Predator
Rhagovelia sp. (1 morphospecies)	Predator
Coleoptera (aquatic beetles)	
Chrysomelidae	
Donacia sp. (1 morphospecies)	Predator
Dryopidae	
Dryops sp. (1 morphospecies)	Predator
Dytiscidae	
Copelatus sp. (1 morphospecies)	Predator
Hydaticus sp. (1 morphospecies)	Predator
Laccophilus sp. (1 morphospecies)	Predator

Taxon	Functional Feeding Groups
Elmidae	
Grouvellinus sp. (1 morphospecies)	Scraper
Pseudamophilus sp. (1 morphospecies)	Scraper
Eulichadidae	
Eulichas sp. (1 morphospecies)	Predator
Gyrinidae	
Porrhorrhynchus marginatus Laporte, 1835	Predator
Haliplidae	
Haliplus sp. (1 morphospecies)	Scraper
Hydrophilidae	
Berosus sp. (1 morphospecies)	Scraper
Coelostoma sp. (1 morphospecies)	Scraper
Hydrophilus sp. (1 morphospecies)	Scraper
Lampyridae	
Indetermined (1 morphospecies)	Scraper
Noteridae	
Noterus sp. (1 morphospecies)	Scraper
Psephenidae	
Eubrianax sp. (1 morphospecies)	Scraper
Scirtidae	
Cyphon sp. (1 morphospecies)	Scraper
Megaloptera (alderflies and fishflies)	
Corydalidae	
Protothermes sp. (1 morphospecies)	Predator
Diptera (true flies)	
Athericidae	
Atherix sp. (1 morphospecies)	Gathering-Collector
Chironomidae	
Chironomus spp. (2 morphospecies)	Gathering-Collector
Culicidae	
Culex sp. (1 morphospecies)	Filtering-Collector
Simuliidae	
Simulium sp. (1 morphospecies)	Filtering-Collector
Tipulidae	
Tipula sp. (1 morphospecies)	Gathering-Collector

FISHES

Tonny Ganyai, Hafida Bolhen, Jongkar Grinang, Karen Lee Suan Ping,Toloy Keripin Munsang* and *Lee Nyanti

The Pelagus area is located in the middle stretches of Batang Rajang, in the central part of Sarawak, under the administrative division of Kapit. The area is well-known for its long and dangerous rapids that extend for a distance of 12.8 km. Over the years, these "rapids of death" have capsized many boats along its treacherous and unpredictable waterways.

To determine the fish composition in the Pelagus area, three study sectors were sampled, namely, Nanga Benin, representing the downstream area; Nanga Peraran, the midstream area; and Punan Bah, which represents the upstream areas. At each sector, sampling stations were established along the Batang Rajang and its tributaries (Fig. 1; Table 1). Field sampling was conducted in April and August of 2014, as well as January and July of 2015. Fishing methods applied include gill nets of various mesh sizes (2.5 cm, 3.81 cm, 5.08 cm, 7.62 cm and 10.16 cm), 3-layered nets, cast nets (Fig. 2–3) and electro-shocking. Similar fishing efforts were employed at the different stations (Fig. 4) and at other study sectors.

Fishes caught were mostly identified in the field (Fig. 5), but others were brought to the laboratory for further study. Representative samples were photographed and preserved in 10% formalin and later transferred into 70% ethanol for long-term preservation.

A total of 3,456 individuals, belonging to 21 families and 86 species were caught from the study area (Table 2). Some of the commonly caught species from Pelagus area are shown in Fig. 6. Members of the Cyprinidae represent 69% of the total individuals caught, with *Nemacheilus kapuasensis* and *Rasbora hosii* being the two most dominant species. Downstream of the Pelagus area, a total of 1,334 fishes, representing 17 families and 61 species were recorded (Table 2). Cyprinidae comprise 56% of the individuals, the dominant species being *Nemacheilus kapuasensis*. The midstream area recorded a total of 1,209 individuals, belonging to 14 families and 62 species (Table 2) and was dominated by the Cyprinidae, comprising 76% of the total individuals. *Rasbora dusonensis* was the dominant species at this area. The upstream area recorded a total of 913 individuals, belonging to 12 families and 46 species (Table 2). Cyprinidae was the dominant family, representing 80% of the total number of individuals, the dominant species being *Rasbora hosii.*

Table 1: Coordinates of sampling stations at Batang Rajang and its tributaries at the three sectors in the Pelagus area.

Sector	Station	Name of River	Coordinates
Nanga Benin (downstream)	DS1	Sg. Kapit Ulu	2.1382°N, 113.0710°E
	DS2	Sg. Mella	2.1326°N, 113.0825°E
	DS3	Sg. Beluli	2.1487°N, 113.0784°E
	DS4	Sg. Raya	2.1526°N, 113.0845°E
	DS5	Sg. Senyamok	2.1636°N, 113.0689°E
	DS6	Sg. Benin	2.1655° N, 113.0687°E
	DS7	Sg. Sap	2.1649°N, 113.0535°E
	DS8	Sg. Amang	2.1753°N, 113.061°E
	DS9	Sg. Mejau	2.1765°N, 113.0419°E
	DS10	Sg. Ngua	2.1794°N, 113.0462°E
	DS11	Btg. Rajang	2.1388°N, 113.0759°E
Nanga Peraran (midstream)	MS1	Sg. Ensawie	2.2530°N, 113.0951°E
	MS2	Sg. Buya	2.2499°N, 113.1265°E
	MS3	Sg. Sama	2.2663°N, 13.1578°E
	MS4	Sg. Rarai	2.2207°N, 113.1456°E
	MS5	Sg. Serian	2.1927°N, 113.1472°E
	MS6	Sg. Peraran Kecil	2.1908°N, 113.1199°E
	MS7	Sg. Pelaran Besar	2.1906°N, 113.1220°E
	MS8	Sg. Lebau	2.2057°N, 113.1079°E
	MS9	Sg. Serau	2.1926°N, 113.0985°E
	MS10	Sg. Sebingol	2.1992°N, 113.0912°E
	MS11	Btg. Rajang	2.2084°N, 113.154°E
Punan Bah (upstream)	US1	Sg. Pangau Kecil	2.4688°N, 113.5064°E
	US2	Sg. Pangau	2.4718°N, 113.4843°E
	US3	Sg. Bon	2.4450°N, 113.4663°E
	US4	Sg. Lanan	2.4283°N, 113.4497°E
	US5	Sg. Benatu	2.3991°N, 113.3740°E
	US6	Sg. Mia	2.3830°N, 113.3803°E
	US7	Sg. Senganya	2.3797°N, 113.3385°E
	US8	Sg. Mikai	2.3474°N, 113.3108°E
	US9	Btg. Rajang	2.4320°N, 113.4364°E

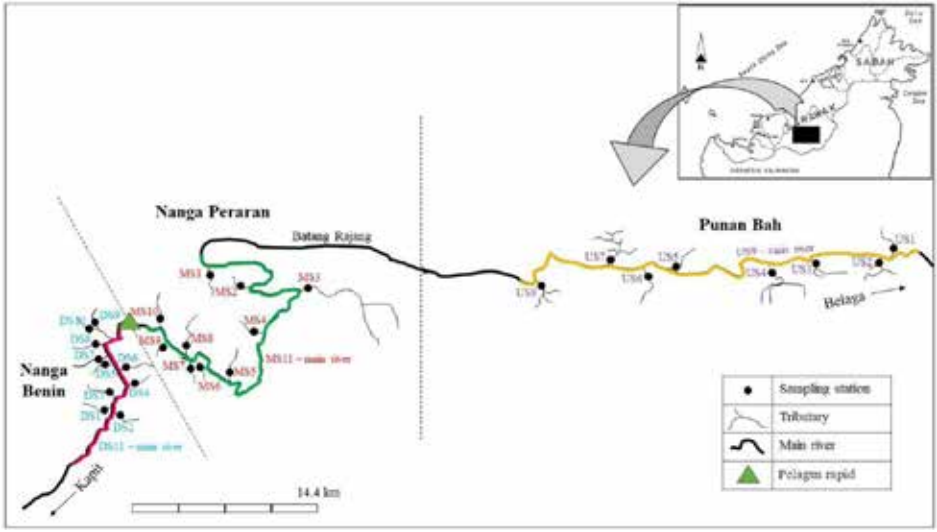


Fig. 1. Sampling stations along Batang Rajang (DS11, MS11 and US9) and its tributaries at three sectors in the Pelagus area: Nanga Benin (downstream area), Nanga Peraran (midstream area) and Punan Bah (upstream area).

Fig. 2. Cast-netting in the rapids to catch *Pangasius macronema*, which is locally known as "Buris".

Fig. 3. 'Buris' is generally targeted by local fishermen for personal consumption, while the larger fishes are sent to the market at Kapit.

Fig. 4. A representative habitat at the tributary of Batang Rajang.

Fig. 5. Fish identification and morphometric measurements at Rumah John, Nanga Benin.

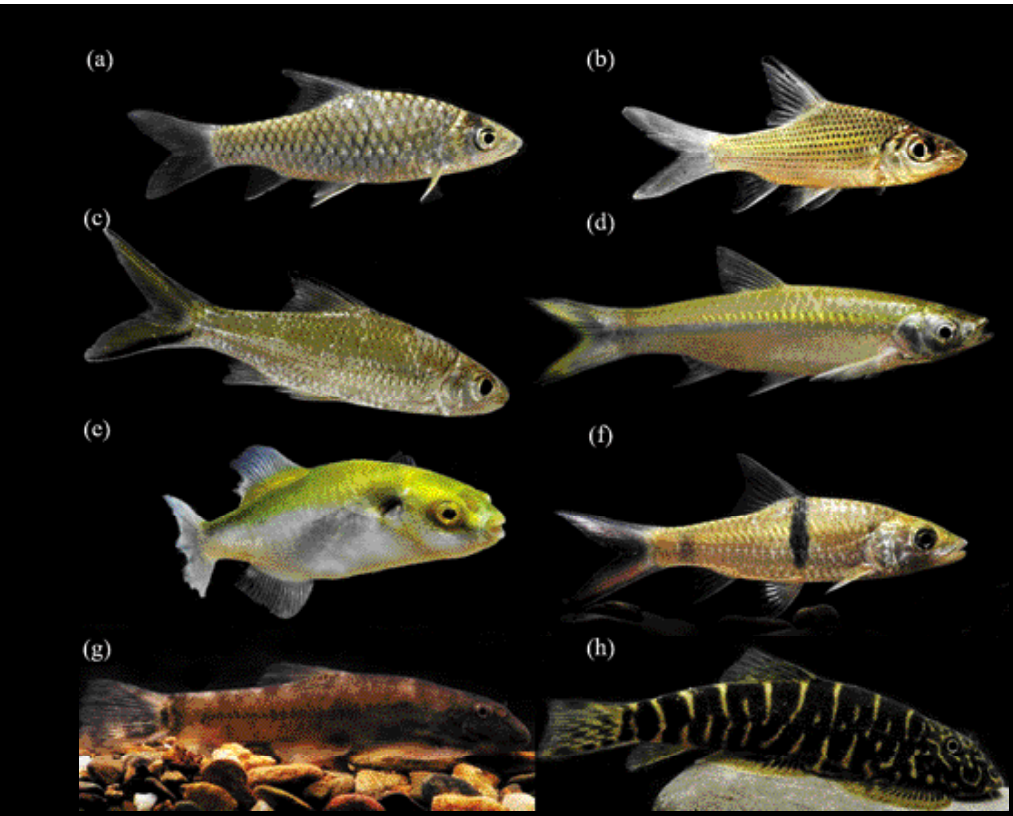


Fig. 6. Representative fish species sampled in Pelagus, Batang Rajang, Sarawak: (a) *Tor tambra;* (b) *Cyclocheilichthys repasson;* (c) *Barbonymus collingwoodii;* (d) *Rasbora dusonensis;* (e) *Auriglobus modestus;* (f) *Hampala macrolepidota;* (g) *Neogastromyzon chini;* (h) *Gastromyzon fasciatus.* Photos: Pui Yong Min.

Table 2: A checklist of fishes of the Pelagus region. Updated 14 May 2020.

Family	Scientific Name	Common Name	River Reach			Habitat	
			Downstream	Middle Stream	Upper Stream	Tributary	Main River
Ambassidae	*Parambassis wolffii* (Bleeker, 1850)	Duskyfin Glassy Perchlet	●				●
Bagridae	*Bagrichthys macracanthus* (Bleeker, 1854)	Black Lancer Catfish		●	●	●	●
	Bagrichthys micranodus Roberts, 1989	Bagrid Catfish		●			●
	Bagroides melapterus Bleeker, 1851	Bagrid Catfish		●			●
	Hemibagrus fortis (Popta, 1904)	Yellow Catfish	●	●	●	●	●
	Hemibagrus capitulum (Popta, 1904)	Bagrid Catfish	●	●	●	●	●
	Hemibagrus wyckii (Bleeker, 1858)	Bagrid Catfish	●		●	●	●
	Mystus nigriceps (Valenciennes, 1840)	Twospot Catfish	●	●	●	●	●
Balitoridae	*Homaloptera orthogoniata* Vaillant, 2002	River Loach		●		●	
	Homalopteroides nebulosus (Alfred, 1969)	River Loach	●	●	●	●	
	Homalopteroides tweediei (Herre, 1940)	River Loach		●		●	
Channidae	*Channa lucius* (Cuvier, 1831)	Snakehead	●	●	●	●	●
	Channa striata (Bloch, 1793)	Striped Snakehead	●	●	●	●	

Family	Scientific Name	Common Name	River Reach			Habitat	
			Downstream	Middle Stream	Upper Stream	Tributary	Main River
Clariidae	*Clarias leiacanthus* Bleeker, 1851	Forest Walking Catfish	●				●
Cobitidae	*Pangio anguillaris* (Vaillant, 1902)	Eel-loach	●		●	●	
	Pangio semicincta (Fraser-Brunner, 1940)	Eel-loach	●	●		●	
	Syncrossus hymenophysa (Bleeker, 1852)	Tiger Botia	●		●	●	●
Cyprinidae	*Barbodes sealei* (Herre, 1933)	Minnow		●		●	
	Barbodes banksi (Herre, 1940)	Spotted Barb	●	●	●	●	
	Barbodes kuchingensis (Herre, 1940)	Barb	●	●		●	
	Barbonymus balleroides (Valenciennes, 1842)	Barb	●	●		●	●
	Barbonymus collingwoodii (Günther, 1868)	Barb	●	●	●	●	●
	Barbonymus gonionotus (Bleeker, 1849)	Silver Barb	●				●
	Barbonymus schwanefeldii (Bleeker, 1854)	Tinfoil Barb	●	●	●	●	●
	Crossocheilus cobitis (Bleeker, 1854)	Minnow		●		●	
	Crossocheilus oblongus (Kuhl & Van Hasselt, 1823)	Siamese Flying Fox		●		●	
	Cyclocheilichthys apogon (Valenciennes, 1842)	Beardless Barb	●	●	●	●	●

Family	Scientific Name	Common Name	River Reach			Habitat	
			Downstream	Middle Stream	Upper Stream	Tributary	Main River
Cyprinidae	*Cyclocheilichthys armatus* (Valenciennes, 1842)	Barb	●	●	●	●	●
	Cyclocheilichthys repasson (Bleeker, 1853)	Barb		●		●	
	Hampala bimaculata (Popta, 1905)	Barb	●	●	●	●	●
	Hampala macrolepidota Kuhl & Van Hasselt, 1823	Hampala Barb	●	●	●	●	●
	Labiobarbus fasciatus (Bleeker, 1853)	Barb	●	●	●	●	
	Labiobarbus festivus (Heckel, 1843)	Signal Barb	●	●	●	●	●
	Labiobarbus leptocheilus (Valenciennes, 1842)	Barb		●		●	
	Labiobarbus ocellatus (Heckel, 1843)	Barb		●		●	
	Lobocheilos ovalis Kottelat & Tan, 2008	Minnow	●	●		●	●
	Lobocheilos cf. *falcifer* (Valenciennes, 1842)	Minnow	●	●	●	●	●
	Luciosoma setigerum (Valenciennes, 1842)	Apollo Shark-minnow	●	●		●	●
	Luciosoma spilopleura Bleeker, 1855	Apollo Shark-minnow	●	●	●	●	●
	Luciosoma trinema (Bleeker, 1852)	Apollo Shark-minnow	●	●		●	

Family	Scientific Name	Common Name	River Reach			Habitat	
			Downstream	Middle Stream	Upper Stream	Tributary	Main River
Cyprinidae	*Osteochilus melanopleurus* (Bleeker, 1852)	Minnow	●		●	●	●
	Osteochilus microcephalus (Valenciennes, 1842)	Minnow	●	●		●	
	Osteochilus schlegelii (Bleeker, 1851)	Giant Shark-minnow	●	●	●	●	●
	Osteochilus vittatus (Valenciennes, 1842)	Bonylip Barb	●	●	●	●	●
	Osteochilus waandersii (Bleeker, 1853)	Minnow	●	●	●	●	●
	Osteochilus sp.	Minnow	●			●	●
	Oxygaster anomalura van Hasselt, 1823	Minnow		●	●	●	●
	Parachela hypophthalmus (Bleeker, 1860)	Minnow	●			●	
	Parachela oxygastroides (Bleeker, 1852)	Glass Fish		●	●	●	●
	Puntioplites waandersi (Bleeker, 1859)	Minnow	●	●	●	●	●
	Rasbora argyrotaenia (Bleeker, 1849)	Silver Rasbora	●			●	●
	Rasbora borneensis (Bleeker, 1860)	Rasbora	●	●	●	●	
	Rasbora dusonensis (Bleeker, 1850)	Rosefin Rasbora	●	●	●	●	
	Rasbora volzii Popta, 1905	Rasbora	●	●	●	●	●

Family	Scientific Name	Common Name	River Reach			Habitat	
			Downstream	Middle Stream	Upper Stream	Tributary	Main River
Cyprinidae	*Rasbora hosii* Boulenger, 1895	Rasbora	●		●	●	
	Rasbora sp.	Rasbora	●			●	
	Tor tambra (Valenciennes, 1842)	Semah Mahseer	●	●		●	
Eleotridae	*Oxyeleotris urophthalmoides* (Bleeker, 1853)	Sleeper	●			●	
Gastromyzontidae	*Gastomyzon punctulatus* Inger & Chin, 1961	Hillstream Loach	●			●	
	Gastromyzon fasciatus Inger & Chin, 1961	Hillstream / oach	●	●		●	
	Neogastromyzon chini Tan, 2006	River Loach	●			●	
	Parhomaloptera microstoma (Boulenger, 1899)	River Loach			●	●	
Gobiidae	*Glossogobius aureus* Akihito & Meguro, 1975	Golden Tank Goby	●			●	
Helostomatidae	*Helostoma temminckii* Cuvier, 1829	Kissing Gourami	●				●
Mastacembelidae	*Macrognathus maculatus* (Cuvier, 1832)	Frecklefin Eel	●	●			●
Nemacheilidae	*Nemacheilus kapuasensis* Kottelat, 1984	Sand-loach	●	●	●	●	
Notopteridae	*Chitala borneensis* (Bleeker, 1851)	Knifefish			●	●	●

Family	Scientific Name	Common Name	River Reach			Habitat	
			Downstream	Middle Stream	Upper Stream	Tributary	Main River
Osphronemidae	*Osphronemus goramy* Lacépède, 1801	Giant Gourami			●	●	●
	Osphronemus septemfasciatus Roberts, 1992	Gourami		●		●	●
Pangasiidae	*Pangasius macronema* Bleeker, 1850	Shark Catfish	●	●	●		●
	Pseudolais micronemus (Bleeker, 1846)	Shortbarbel Pangasius	●	●	●	●	●
	Pangasius nasutus (Bleeker, 1863)	Shark Catfish	●			●	●
	Pangasius nieuwenhuisii (Popta, 1904)	Shark Catfish	●			●	●
Pristolepididae	*Pristolepis grootii* (Bleeker, 1852)	Indonesian Leaffish		●	●	●	●
Siluridae	*Kryptopterus bicirrhis* (Valenciennes, 1840)	Glass Catfish	●	●		●	●
	Kryptopterus cryptopterus (Bleeker, 1851)	Sheatfish		●	●	●	●
	Kryptopterus lais (Bleeker, 1851)	Sheatfish	●		●	●	●
	Kryptopterus limpok (Bleeker, 1852)	Long-barbel Sheatfish	●	●	●		●
	Kryptopterus macrocephalus (Bleeker, 1858)	Striped Glass Catfish		●	●	●	●
	Kryptopterus minor Roberts, 1989	Ghost Catfish		●	●		●

Family	Scientific Name	Common Name	River Reach			Habitat	
			Downstream	Middle Stream	Upper Stream	Tributary	Main River
Siluridae	*Kryptopterus schilbeides* (Bleeker, 1858)	Sheatfish		●	●	●	
	Phalacronotus apogon (Bleeker, 1851)	Sheatfish		●	●	●	●
	Wallago leerii Bleeker, 1851	Striped Wallago Catfish		●		●	●
Sisoridae	*Glyptothorax platypogon* (Valenciennes, 1840)	Sisorid Catfish	●	●		●	
Tetraodontidae	*Auriglobus modestus* (Bleeker, 1850)	Pufferfish	●			●	●
Zenarchopteridae	*Hemirhamphodon kuekenthali* Steindachner, 1901	Halfbeak		●		●	

AMPHIBIANS

Pui Yong Min, Mohamad Paisal, Adi Shabrani* and *Indraneil Das

A total of 8,151 species of amphibians have been described globally, with 6,794 (84%) assessed under the IUCN Red List of 2020, of which 2,200 (41%) have been classified as 'Threatened'. Of the approximately 190 species now known from Borneo, 130 (68%) are endemic to the island and 83 species are 'Threatened', representing nearly half of the known amphibian fauna. These figures are, of course, conservative estimates, as many species have yet to be evaluated due to lack of information on threats, and limited knowledge on species distributions, which are often biased towards accessible areas. The insufficiency in the current knowledge on Bornean frogs highlights the need for species inventories, especially in less accessible areas.

Limited literature exists on the herpetofauna of the Pelagus region. This chapter provides an updated inventory of the amphibians found in the Pelagus National Park, based on results of multiple surveys conducted between 2014 to 2015, and those recorded previously. Standardised visual and encounter surveys were conducted between 1900 to 2200 hours along streams and adjacent areas, extending from the bank of the river which demarcates the Park's western boundary, up to the ridge-top along the Bidai Trail, north-west of the site of the former resort within the Park. In addition, an automated sound recording device (Song Meter™ Model SM2+; Wildlife Acoustics Inc.) was established circa 2 m from the stream bank, to remotely record frog vocalization patterns. The sampling regime of 5 min (recording time frame) every 15 min (recording time gap) resulted in 2,700 sampling intervals and 13,500 total minutes of recording time.

The current species inventory for Pelagus National Park documents 39 species, representing 22 genera and seven families. These constitute 21% of the amphibian species recorded on Borneo, 21 of which are endemic to the island. Two of these – the Wallace's Flying Frog (*Rhacophorus nigropalmatus*) and Crested Toad (*Ingerophrynus divergens*) – were solely detected on the automated sound recorder. A species of conservation importance, the Lesser Rock Skipper (*Staurois parvus*), listed as 'Vulnerable' in the IUCN Red List, was found on a sapling along the stream bank. Three 'Near Threatened' species, including the Peat Swamp Frog (*Limnonectes malesianus*), the Serasin Dwarf Litter Frog (*Leptobrachella serasanae*) and Cinnamon Frog (*Nytixalus pictus*) were also recorded from the site.

BUFONIDAE

Fig. 1. Representative species of bufonids found in Pelagus National Park. (a) *Ansonia leptopus*; (b) *Ansonia longidigita*; (c) *Rentapia hosii*; (d) *Ingerophrynus divergens*; (e) *Phrynoides asper*; (f) *Ansonia minuta*.

DICROGLOSSIDAE

Fig. 2. Representative species of *Limnonectes* found in Pelagus National Park. (a) *Limnonectes ibanorum*; (b) *Limnonectes leporinus*; (c) male *Limnonectes kuhlii*.

The amphibian fauna of the Park is rich and includes a number of globally-threatened species. The automated recording device deployed was shown to be effective in detecting species not recorded during transect walks, especially species that are visually cryptic and whose detection may often rely on advertisement calls. Our surveys covered a small part of the Park. More studies are needed in other significant areas of the Park. The current inventory provides baseline information for future, more intensive studies that are focussed on surveys to compile species lists, life history and conservation needs of the Park's interesting frog fauna, all of which are relevant to their management.

A Checklist of Amphibians

IUCN Status (IUCN, 2020): NE – Not Evaluated, LC – Least Concern, NT – Near Threatened, VU – Vulnerable. *Detected by automated recording device.

Species	Common Name	IUCN Status	Endemism
BUFONIDAE			
Ansonia leptopus (Günther, 1872)	Brown Slender Toad	LC	Endemic
Ansonia longidigita Inger, 1960	Long-fingered Slender Toad	LC	Endemic
Ansonia minuta Inger, 1960	Dwarf Slender Toad	LC	Endemic
Ingerophrynus divergens (Peters, 1871) *	Forest Toad	LC	-
Pelophryne sp.	Dwarf Toad	NE	Endemic
Phrynoidis asper (Gravenhorst, 1829)	River Toad	LC	-
Rentapia hosii (Boulenger, 1892)	Brown Tree Toad	LC	-
CERATOBATRACHIDAE			
Alcalus cf. *baluensis* (Boulenger, 1896)	Kinabalu Dwarf Mountain Frog	LC	Endemic
DICROGLOSSIDAE			
Limnonectes ibanorum (Inger, 1964)	Rough-backed River Frog	LC	Endemic
Limnonectes kuhlii (Tschudi, 1838)	Kuhl's Creek Frogs	LC	-
Limnonectes leporinus (Andersson, 1923)	Giant River Frog	LC	Endemic
Limnonectes malesianus (Kiew, 1984)	Peat Swamp Frog	NT	-
Limnonectes sp.	Creek Frog	NE	Endemic
Megophryidae			
Leptobrachella mjobergi Smith, 1925	Mjoberg's Dwarf Litter Frog	LC	Endemic
Leptobrachella juliandringi Eto, Matsui & Nishikawa, 2015	Dring's Dwarf Litter Frog	NE	Endemic
Leptobrachella parva Dring, 1984	Rough-sided Dwarf Litter Frog	LC	Endemic
Leptobrachella serasanae Dring, 1983	Serasin Dwarf Litter Frog	NT	-
Leptobrachium abbotti (Cochran, 1926)	Lowland Litter Frog	LC	Endemic

Species	Common Name	IUCN Status	Endemism
Leptolalax gracilis (Günther, 1872)	Sarawak Slender Litter Frog	LC	Endemic
Megophrys edwardinae Inger, 1989	Edwardine's Horned Frog	LC	Endemic
Megophrys nasuta (Schlegel, 1858)	Bornean Horned Frog	LC	-
MICROHYLIDAE			
Chaperina fusca Mocquard, 1892	Saffron-bellied Frog	LC	-
Nanohyla petrigena (Inger & Frogner, 1979)	Kapit Rice Frog	LC	Endemic
RANIDAE			
Chalcorana raniceps (Peters, 1871)	White-lipped Frog	LC	-
Meristogenys phaeomerus (Inger and Gritis, 1983)	Kapit Torrent Frog	LC	Endemic
Pulchrana picturata (Boulenger, 1920)	Spotted Stream Frog	LC	-
Pulchrana signata (Günther, 1872)	Striped Stream Frog	LC	-
Staurois guttatus (Günther, 1858)	Black-spotted Rock Frog	LC	Endemic
Staurois parvus Inger and Haile, 1959	Lesser Rock Skipper	VU	Endemic
Staurois tuberilinguis Boulenger, 1918	Green Spotted Rock Skipper	LC	Endemic
RHACOPHORIDAE			
Kurixalus chaseni (Smith, 1924)	Frilled Tree Frog	LC	-
Leptomantis gauni (Inger, 1966)	Short-nosed Tree Frog	LC	Endemic
Nyctixalus pictus (Peters, 1871)	Cinnamon Frog	NT	-
Philautus hosii (Boulenger, 1895)	Hose's Bush Frog	LC	Endemic
Philautus tectus (Boulenger, 1895)	Obscure Bush Frog	LC	Endemic
Polypedates leucomystax (Gravenhorst, 1829)	Four-lined Tree Frog	LC	-
Polypedates otilophus (Boulenger, 1893)	File-eared Tree Frog	LC	-
Rhacophorus nigropalmatus Boulenger, 1895*	Wallace's Flying Frog	LC	-
Rhacophorus pardalis Günther, 1858	Harlequin Flying Frog	LC	-

MEGOPHRYIDAE

Fig. 3. Representative species of Megophryidae found in Pelagus National Park. (a) *Leptolalax gracilis*; (b) *Leptobrachium abbotti*; (c) *Megophrys nasuta*; (d) *Megophrys edwardinae*; (e) Near Threatened *Leptobrachella serasanae*; (f) *Leptobrachella mjobergi*.

RANIDAE

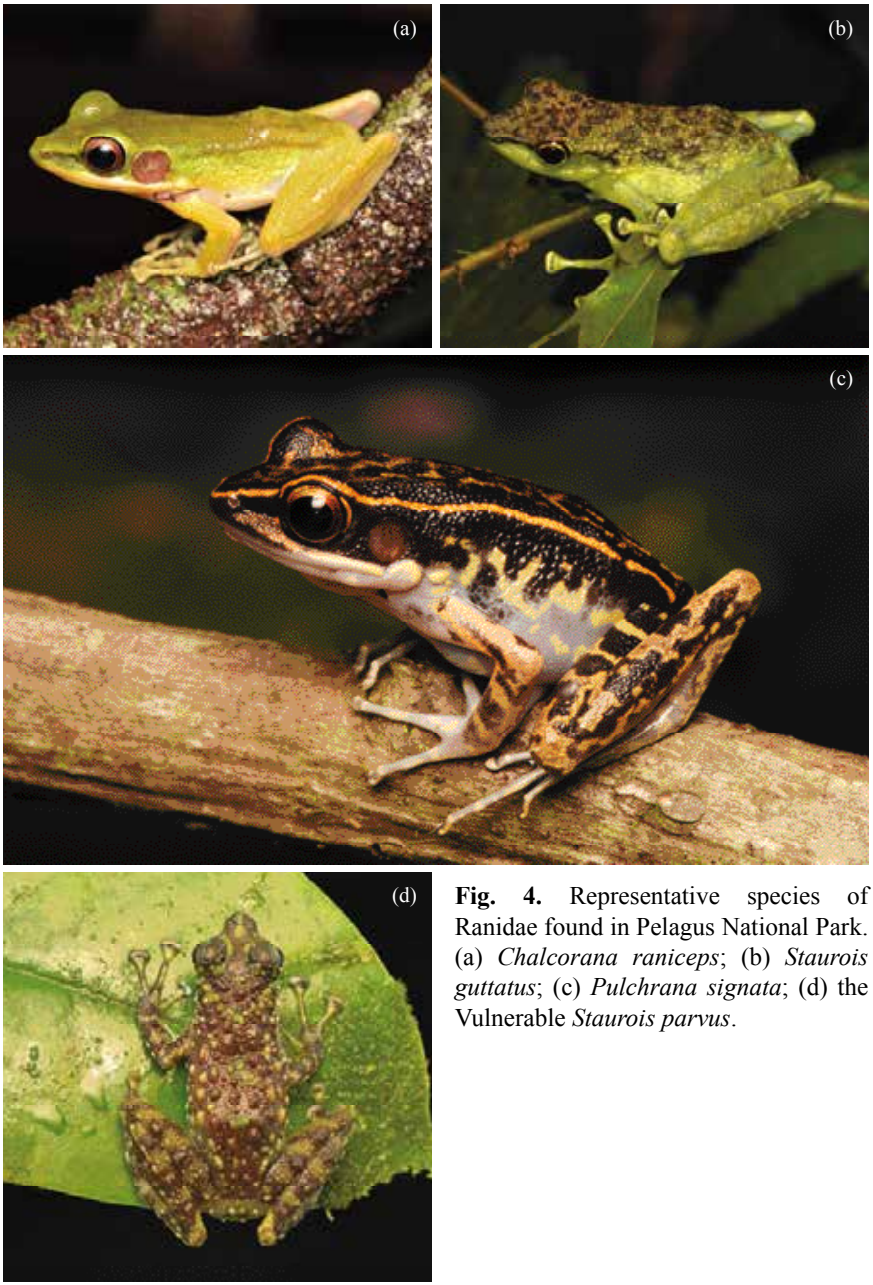


Fig. 4. Representative species of Ranidae found in Pelagus National Park. (a) *Chalcorana raniceps*; (b) *Staurois guttatus*; (c) *Pulchrana signata*; (d) the Vulnerable *Staurois parvus*.

RHACOPHORIDAE

Fig. 5. Representative species of Rhacophoridae found in Pelagus National Park. (a) *Kurixalus chaseni*; (b) *Nyctixalus pictus*; (c) *Polypedates leucomystax*; (d) *Polypedates otilophus*; (e) *Philautus hosii*; (f) *Leptomantis gauni*; (g) *Rhacophorus pardalis*; (h) *Rhacophorus nigropalmatus*.

REPTILES

Indraneil Das, Pui Yong Min, Adi Shabrani, Benjamin R. Karin* and *Mohamad Paisal Wahab

We report an inventory of reptiles recorded at the Pelagus National Park, between May 2014 and April 2015. Information from an earlier trip made in 2003 and a museum record have been included in the species list. Transect walks and visual encounter surveys were employed, but given the short periods available for sampling, limited pitfall-trapping could be conducted. A total of 26 species of reptiles were recorded, as presented. These include 21 lizards and four snakes, as well as unconfirmed reports of a crocodilian. A general impression of the reptile fauna at the Pelagus National Park is that it is a subset of the assemblage found in the widespread lowland Bornean hill dipterocarp forests. Nonetheless, a leaf litter skink of the genus *Sphenomorphus* is undescribed, and several others are recognised as belonging to taxonomically 'problematic' groups.

Of the species in the list, the Bornean Earless Monitor (*Lanthanotus borneensis*) is considered to be under threat, as it is subject to trade and also suffering from habitat loss and fragmentation. This lizard is 'Totally Protected" under Sarawak's Wildlife Laws. The Earless Monitor was not encountered during our recent surveys within the boundaries of the Park, but was recorded from the site by Robert Shelford, English Curator of the Sarawak Museum, in the early part of the last century.

Four lizards belonging to taxonomically 'problematic' groups represent members of their respective species complexes. When taxonomic studies are completed, these are likely to be species endemic to the region or at least shown to have far more restricted species ranges than currently assumed. Since range size is an important determinant of IUCN's conservation status ranking, reduction of species distribution ranges has the potential to heighten the threatened status of these lizards.

Turtle species are conspicuously absent from the Park's reptile checklist, but a few species may be expected to appear in future surveys. These include the softshell turtles *Dogania subplana* and *Amyda cartilaginea*, as well as semi-terrestrial and terrestrial forms encountered at the nearby wet market of Kapit. These are *Cyclemys enigmatica* and *Cuora amboinensis,* and more rarely, *Manouria emys*.

The Estuarine Crocodile, *Crocodylus porosus*, although not observed in

recent surveys, was said to occur along the Pelagus bank of the Sungei Rajang, and downstream, from the Kapit region, both by local inhabitants as well as separate research teams during independent eye-shine surveys.

The limited species list for a tropical area is indicative of inadequate sampling efforts. Long-term field investigations, using multiple trapping techniques, have the potential to quadruple the species count, judging from species richness figures for similar lowland forest habitats on Borneo.

A Checklist of Reptiles

Species recorded from Pelagus National Park, Batang Rajang (current: 23 August 2020). IUCN Status (IUCN, 2020): NE – Not Evaluated, and LC – Least Concern.

Species	Common Name	Status	Endemism	Remarks
Squamata (Lizards)				
Agamidae				
Bronchocela cristatella (Kuhl, 1820)	Green Crested Lizard	NE	-	Member of a species complex
Draco cornutus Günther, 1864	Horned Flying Lizard	LC	+	
Draco obscurus Boulenger, 1887	Dusky Flying Lizard	LC	+	
Draco quinuefasciatus Hardwicke & Gray, 1827	Five-lined Flying Lizard	NE		
Gonocephalus bornensis (Schlegel, 1848)	Bornean Angleheaded Lizard	LC	+	
Gonocephalus grandis (Gray, 1845)	Great Angleheaded Lizard	LC	-	
Pelturagonia cf. *nigrilabris* (Peters, 1864)	Black-lipped Shrub Lizard	LC	+	Member of a species complex
Eublepharidae				
Aeluroscalabotes felinus (Günther, 1864)	Cat Gecko	LC	-	Member of a species complex
Gekkonidae				
Cyrtodactylus consobrinus (Peters, 1871)	Peters' Bow-fingered Gecko	NE	-	
Cyrtodactylus hantu Davis, Bauer, Jackman, Nashriq & Das, 2021	Pelagus Grooved Bow-fingered Gecko	LC	+	Member of a species complex

Species	Common Name	Status	Endemism	Remarks
Gekko horsfieldii (Gray, 1827)	Horsfield's Flying Gecko	LC		
Gekko monarchus (Schlegel in: Duméril & Bibron, 1836)	Spotted House Gecko	NE	-	
Lanthanotidae				
Lanthanotus borneensis Steindachner, 1877	Borneo Earless Monitor	NE	+	
Scincidae				
Dasia vittata (Edeling, 1864)	Striped Tree Skink	LC	+	
Eutropis multifasciata (Kuhl, 1820)	Common Sun Skink	LC	-	
Eutropis rudis (Boulenger, 1887)	Striped Ground Skink	NE	-	
Sphenomorphus cf. *multisquamatus* Inger, 1958	Many-scaled Litter Skink	LC	+	
Tropidophorus beccarii Peters, 1871	Beccari's Water Skink	LC	+	
Tropidophorus brookei (Gray, 1845)	Brook's Water Skink	LC	+	
Tytthoscincus hallieri (van Lidth de Jeude, 1905)	Hallier's Litter Skink	LC	+	
Varanidae				
Varanus salvator (Laurenti, 1768)	Water Monitor	LC	-	
Squamata (Snakes)				
Colubridae				
Boiga drapiezii (Boie, 1827)	White-spotted Cat Snake	LC	-	
Boiga jaspidea (Duméril, Bibron & Duméril, 1854)	Jasper Cat Snake	LC	-	
Lycodon albofuscus (Duméril, Bibron & Duméril, 1854)	Dusky Wolf Snake	LC	-	
Opisthotropis typica (Mocquard, 1890)	Corrugated Water Snake	LC	+	
Crocodylia (Crocodilians)				
Crocodylidae				
Crocodylus porosus Schneider, 1801	Saltwater Crocodile	LC	-	

Fig. 1. (a) *Draco obscurus*; (b) *Draco quinquefasciatus*; (c) *Pelturagonia* cf. *nigrilabris*; (d) *Aeluroscalabotes felinus*; (e) *Cyrtodactylus consobrinus.*

Fig. 2. (a) *Cyrtodactylus hantu*; (b) *Dasia vittata*; (c) *Lanthanotus borneensis;* (inset) *Lanthanotus borneensis*.

Fig. 3. (a) *Sphenomorphus* cf. *multisquamatus*; (b), *Tytthoscincus hallieri*; (c) *Varanus salvator*; (d) *Boiga drapiezii*; (e) *Boiga jaspidea.*

THE BIRDS

Pang Sing Tyan, Attiqqah Fadziliah Sapian, Khatijah Ismail, Rahah Mohd. Yakup, Mohd. Hasri Al-Hafiz Haba, Isa Sait* and *Andrew Alek Tuen

The 2041-hectare Pelagus National Park is accessible via the Rajang River near the Pelagus Rapids. The main entrance to the Park is via the now abandoned Pelagus Resort and surrounding this resort on the hills is mixed dipterocarp forest that had been logged once about 50 years ago. Several local settlements, located outside the Park boundary, are found along the bank of the Rajang. These communities have worked the land behind their respective longhouses for many generations resulting in a mosaic of agricultural landscape, secondary and logged-over forests on which the local community depended for various resources.

Birds play an important role in the life of the local community in Pelagus. The daily activities they engage in, such as farming, fishing, hunting and housebuilding are guided by augural birds. The presence of a Rufous-backed Kingfisher is believed to be an ill omen for events such as the longhouse's destruction by fire. Other augural birds occurring in the area are the Rufous Piculet (Iban name *ketupong)*, Banded Kingfisher (*embuas)*, Scarlet-rumped Trogon (*beragai*), Diard's Trogon (*papau*), Crested Jay (*bejampong*), Maroon Woodpecker (*pangkas*) and White-rumped Shama (*nendak*). Some larger species of birds are hunted for their meat. Hornbills are not only a source of meat for the local community, their feathers have aesthetic value and are used in tribal ceremonies.

Ecologically, birds are well-known bioindicators of forest health. The presence of hornbills in Pelagus indicates the existence of large trees, within and outside the Park, which hornbills need for resting, nesting and nursing their young. Like hornbills which are exclusive frugivores barbets and pigeons also occur in the area, signifying presence of fruiting trees in Pelagus forests. Frugivores such as doves, pigeons and barbets disperse fruits and seeds, thus helping in the regeneration of forests. Birds also serve as bio-control agents. Insectivorous birds, such as woodpeckers, babblers and flycatchers keep populations of insects in check. Owls and large-bodied kingfishers may also take small mammals such as rats, which help farmers reduce paddy field pests.

Bird surveys were conducted inside the Park and in the forests behind the longhouses, between December 2015 and November 2016. Mist netting

Fig. 1. (a) Black-bellied Malkoha; (b) Black-thighed Falconet. Photo: Chien C. Lee; (c) Blue-eared Kingfisher; (d) Dusky Munia; (e) Gould's Frogmouth; (f) Hill Myna.

Fig. 2. Great Argus Pheasant. Photo: Chien C. Lee.

and observational methods were employed. A total of 80 double-stacked nets (two nets, bottom of one stitched to the top of another) were put up at selected sites to trap birds that are on the ground and up to 3.6 metres level in the understorey. The total netting effort was 30,720 hours. Observational surveys were conducted along five 1-km transects to record birds that occupy the understorey, canopy and above canopy, thus taking into account birds that are seldom captured in mist nets.

A total of 47 species of birds were recorded at Pelagus National Park, 16 of which were recorded only in the Park, 11 through observation and five by mist net. The avifauna recorded exclusively in the Park include the Great Argus, Cinnamon-headed Pigeon, Lesser Coucal, Black-bellied Malkoha, Banded Bay Cuckoo, House Swift, Lesser Fish-eagle, Black-thighed Falconet, Long-tailed Parakeet, Spotted Fantail, Black Magpie, Moustached Hawk-cuckoo, Maroon Woodpecker, Grey-bellied Bulbul, Dark Blue Flycatcher and Thick-billed Spiderhunter. This implies that these species may be habitat-specialists and prefer primary forests.

An additional 131 species were also encountered via mist-netting and observations within the forests behind the longhouses, making it a total of 178 species in the area. Nine Borneo endemic species recorded include the rare ground-dwelling Blue-banded Pitta, the widely distributed but scarce Bornean Bristlehead with a distinctive call, Bornean Banded Kingfisher, Bornean Brown Barbet, Chestnut-crested Yuhina, Bornean Blue Flycatcher, Yellow-rumped Flowerpecker, Bornean Spiderhunter and Dusky Munia.

Under the International Union for Conservation of Nature (IUCN) Red List of Threatened Species 2020, 45 species are categorised as Near Threatened and 10 as Threatened. Among the Threatened, the following are subcategorised as Vulnerable: the Large Green Pigeon, Rhinoceros Hornbill, Black Hornbill, Wreathed Hornbill, Long-tailed Parakeet, Brown-chested Jungle Flycatcher and Greater Green Leafbird; the White-crowned hornbill as endangered; and the Helmeted Hornbill and Blue-banded Kingfisher as Critically Endangered.

Eleven species in the list are totally protected while 29 are protected under the Sarawak Wild Life Protection Ordinance, 1998. All the six hornbill species and the three pittas found in Pelagus are Totally Protected. The Great Argus Pheasant and Long-tailed Parakeet are also Totally Protected.

All water birds are protected in Sarawak. The water birds recorded in Pelagus include three species of egrets, a heron and a sandpiper. All the recorded kingfishers in the family Alcedinidae, woodpeckers in the family Picidae, the Blue-breasted Quail, Crested Serpent-eagle, Crested Goshawk, Lesser Fish-eagle, Black-thighed Falconet, Blue-crowned Hanging Parrot, Indian Paradise Flycatcher, White-rumped Shama and the Common Hill Myna, are protected as well.

Fig. 3. (a) Thick-billed Spiderhunter. Photo: Chien C. Lee; (b) White-breasted Waterhen.

Although the survey effort in Pelagus National Park was comparatively less than in surrounding sites where eight endemic and ten threatened species were documented, the Park had a record of four Borneo endemics: Bornean Blue Flycatcher, Yellow-rumped Flowerpecker, Dusky Munia and Bornean Brown Barbet; four species under the IUCN Threatened category were also recorded: the Rhinoceros Hornbill, Black Hornbill, White-crowned Hornbill and Long-tailed parakeet. The Park also supports species protected by Sarawak Wild Life Protection Ordinance 1998, including 16 species under the Protected category and seven as Totally Protected, whereas the surrounding site support 26 Protected and 11 Totally Protected bird species.

The high bird species diversity recorded both inside the Park and the surrounding sites along with the significant number of species being of conservation importance, make the Pelagus area a priority for bird tourism, conservation and research in Sarawak.

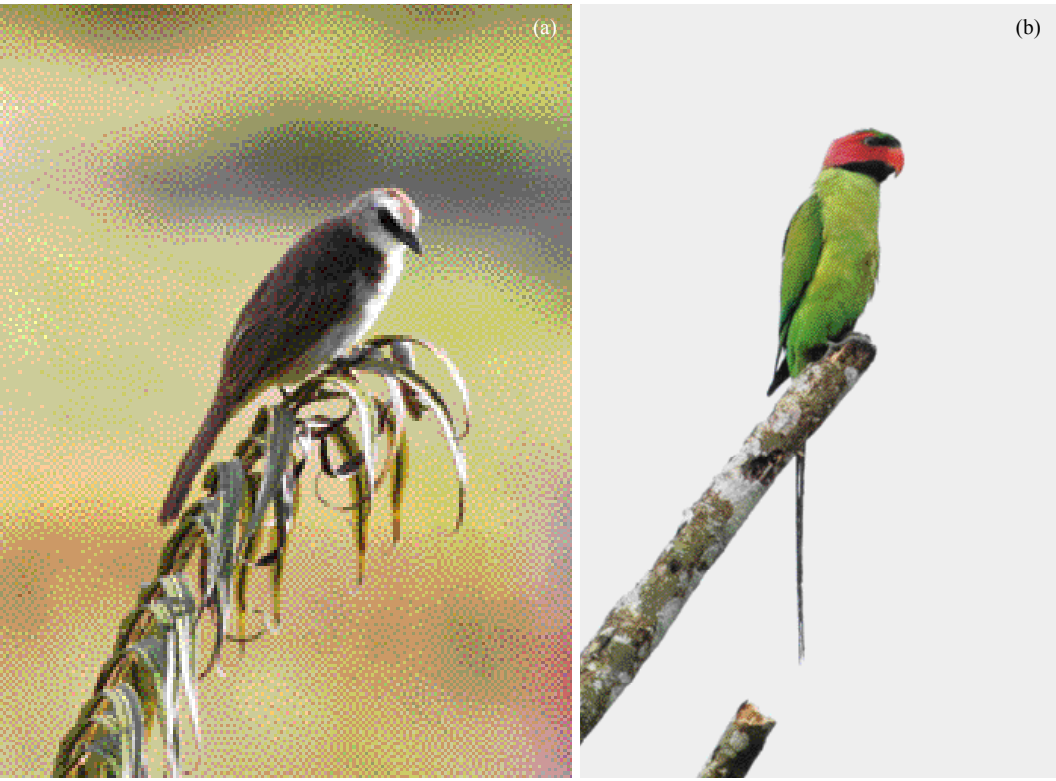


Fig. 4. (a) Yellow-vented Bulbul; (b) Long-tailed Parakeet.

A Checklist of Birds

** totally protected species; *protected species; # endemic to Borneo;
[x] recorded only by mist-nets

Species	Common Name
PHASIANIDAE	
Coturnix chinensis (Linnaeus, 1766)	Blue-breasted Quail*
Argusianus argus (Linnaeus, 1766)	Great Argus**
ARDEIDAE	
Butorides striata (Linnaeus, 1758)	Striated Heron*
Egretta garzetta (Linnaeus, 1766)	Little Egret*
Egretta intermedia (Wagler, 1827)	Intermediate Egret*
Ardea alba (Linnaeus, 1758)	Great Egret*
ACCIPITRIDAE	
Ichthyophaga humilis (Müller & Schlegel, 1841)	Lesser Fish-eagle*
Spilornis cheela Latham, 1790	Crested Serpent Eagle*
FALCONIDAE	
Microhierax fringillarius (Drapiez, 1824)	Black-thighed Falconet*
Accipiter trivirgatus (Temminck, 1824)	Crested Goshawk*
RALLIDAE	
Amaurornis phoenicurus Pennant, 1769	White-breasted Waterhen
SCOLOPACIDAE	
Actitis hypoleucos (Linnaeus, 1758)	Common Sandpiper*
COLUMBIDAE	
Chalcophaps indica (Linnaeus, 1758)	Emerald Dove[x]
Treron curvirostra (Gmelin, 1789)	Thick-billed Green Pigeon
Treron fulvicollis (Wagler, 1827)	Cinnamon-headed Green Pigeon
Treron olax (Temminck, 1823)	Little Green Pigeon
Treron vernans (Linnaeus, 1771)	Pink-necked Green Pigeon
Treron capellei (Temminck, 1823)	Large Green Pigeon
PSITTACULIDAE	
Psittacula longicauda (Boddaert, 1783)	Long-tailed Parakeet**
Loriculus galgulus (Linnaeus, 1758)	Blue-crowned Hanging Parrot*
CULCULIDAE	
Hierococcyx vagans (Müller, 1845)	Moustached Hawk-Cuckoo[x]
Hierococcyx fugax Horsfield, 1821	Javan Hawk-Cuckoo[x]
Cuculus micropterus (Gould, 1837)	Indian Cuckoo

Species	Common Name
Chrysococcyx xanthorhynchus (Horsfield, 1821)	Violet Cuckoo
Cacomantis sonneratii (Latham, 1790)	Banded Bay Cuckoo
Cacomantis merulinus (Scopoli, 1786)	Plaintive Cuckoo[x]
Surniculus lugubris (Horsfield, 1821)	Square-tailed Drongo Cuckoo
Centropus sinensis (Stephens, 1815)	Greater Coucal
Centropus bengalensis (Gmelin, 1788)	Lesser Coucal
Clamator coromandus (Linnaeus, 1766)	Chestnut-winged Cuckoo
Phaenicophaeus diardi (Lesson, 1830)	Black-bellied Malkoha
Zanclostomus javanicus Horsfield, 1821	Red-bellied Malkoha[x]
Phaenicophaeus curvirostris (Shaw, 1810)	Chestnut-breasted Malkoha
Rhinortha chlorophaea (Raffles, 1822)	Raffles's Malkoha
STRIGIDAE	
Otus rufescens (Horsfield, 1821)	Reddish Scops Owl[x]
Otus brookii (Sharpe, 1892)	Rajah Scops Owl[x]
PODARGARIDAE	
Batrachostomus stellatus (Gould, 1837)	Gould's Frogmouth[x]
CAPRIMULGIDAE	
Eurostopodus temminckii (Gould, 1838)	Malaysian Eared Nightjar
APODIDAE	
Apus nipalensis (Hodgson, 1837)	House Swift*
Hemiprocne comata (Temminck, 1824)	Whiskered Treeswift
Collocalia esculenta (Linnaeus, 1758)	Glossy Swiftlet
TROGONIDAE	
Harpactes diardii (Temminck, 1832)	Diard's Trogon
Harpactes kasumba (Raffles, 1822)	Red-naped Trogon
Harpactes duvaucelii (Temminck, 1824)	Scarlet-rumped Trogon
ALCEDINIDAE	
Actenoides concretus (Temminck, 1825)	Rufous-collared Kingfisher*
Alcedo atthis (Linnaeus, 1758)	Common Kingfisher*
Alcedo meninting Horsfield, 1821	Blue-eared Kingfisher*
Alcedo peninsulae Temminck, 1830	Blue-banded kingfisher*[x]
Pelargopsis capensis (Linnaeus, 1766)	Stork-billed Kingfisher*
Ceyx rufidorsa (Linnaeus, 1758)	Rufous-backed Dwarf-Kingfisher*
Lacedo melanops (Horsfield, 1821)	Bornean Banded Kingfisher[#]*[x]
MEROPIDAE	
Nyctyornis amictus (Temminck, 1824)	Red-bearded Bee-Eater

Species	Common Name
BUCEROTIDAE	
Aceros comatus (Raffles, 1822)	White-crowned Hornbill**
Anorrhinus galeritus (Temminck, 1831)	Bushy-crested Hornbill**
Anthracoceros malayanus (Raffles, 1822)	Asian Black Hornbill**
Rhyticeros undulatus (Shaw, 1811)	Wreathed Hornbill**
Buceros rhinoceros Linnaeus, 1758	Rhinoceros Hornbill**
Buceros vigil (Forster, 1781)	Helmeted Hornbill**
RAMPHASTIDAE	
Megalaima henricii (Temminck, 1831)	Yellow-crowned Barbet
Megalaima chrysopogon (Temminck, 1824)	Gold-whiskered Barbet
Megalaima rafflesii (Lesson, 1839)	Red-crowned Barbet
Megalaima mystacophanos (Temminck, 1824)	Red-throated Barbet
Megaliama australis (Horsfield, 1821)	Blue-eared Barbet
Calorhamphus fuliginosus (Temminck, 1830)	Bornean Brown Barbet#
INDICATORIDAE	
Indicator archipelagicus Temminck, 1832	Malaysian Honeyguide
PICIDAE	
Dinopium rafflesii (Temminck, 1825)	Olive-backed woodpecker*[x]
Blythipicus rubiginosus (Swainson, 1837)	Maroon Woodpecker*
Celeus brachyurus (Vieillot, 1818)	Rufous Woodpecker*[x]
Picus miniaceus Pennant, 1769	Banded Woodpecker*
Picus puniceus Horsfield, 1821	Crimson-winged Woodpecker*
Sasia abnormis (Temminck, 1825)	Rufous Piculet*
Meiglyptes grammithorax (Malherbe, 1862)	Buff-rumped Woodpecker*[x]
Meiglyptes tukki (Lesson, 1839)	Buff-necked Woodpecker*
Dendrocopus canicapillus (Blyth, 1845)	Grey-capped Woodpecker*
EURYLAIMIDAE	
Corydon sumatranus (Raffles, 1822)	Dusky Broadbill
Cymbirhynchus macrorhynchos (Gmelin, 1788)	Black-and-red Broadbill[x]
Eurylaimus javanicus Horsfield, 1821	Banded Broadbill
Eurylaimus ochromalus Raffles, 1822	Black-and-yellow Broadbill
CALYPTOMENIDAE	
Calyptomena viridis Raffles, 1822	Green Broadbill
PITTIDAE	
Pitta arquata (Gould, 1871)	Blue-banded Pitta**#

Species	Common Name
Pitta granatina (Temminck, 1830)	Garnet Pitta**
Pitta moluccensis (Statius Müller, 1776)	Blue-winged Pitta**
AEGITHINIDAE	
Aegithina tiphia (Linnaeus, 1758)	Common Iora
CHLOROPSEIDAE	
Chloropsis cyanopogon (Temminck, 1829)	Lesser Green Leafbird[x]
Chloropsis sonnerati Jardine & Selby, 1827	Greater Green Leafbird[x]
Chloropsis cochinchinensis Gmelin, 1789	Blue-winged Leafbird
CAMPEPHAGIDAE	
Lalage nigra (Forster, 1781)	Pied Triller
ORIOLIDAE	
Oriolus xanthonotus Horsfield, 1821	Dark-throated Oriole
IRENIDAE	
Irena puella (Latham, 1790)	Asian Fairy-bluebird
DICRURIDAE	
Dicrurus aeneus Vieillot, 1817	Bronzed Drango
Dicrurus paradiseus (Linnaeus, 1766)	Greater Racket-tailed Drongo
CORVIDAE	
Platysmurus leucopterus (Temminck, 1824)	Black Magpie
Platylophus galericulatus (Cuvier, 1817)	Crested Jay
PITYRIASIDAE	
Pityriasis gymnocephala (Temminck, 1835)	Bornean Bristlehead#
ARTAMIDAE	
Artamus leucorynchus (Linnaeus, 1771)	White-breasted WoodSwallow
CISTICOLIDAE	
Orthotomus sericeus Temminck, 1836	Rufous-tailed Tailorbird
Orthotomus ruficeps (Lesson, 1830)	Red-headed Tailorbird
Prinia flaviventris (Delessert, 1840)	Yellow-bellied Prinia
PYCNONOTIDAE	
Brachypodius atriceps (Temminck, 1822)	Black-headed Bulbul
Brachypodius melanoleucos (Eyton, 1839)	Black-and-White Bulbul[x]
Rubigula cyaniventris Blyth, 1842	Grey-bellied Bulbul[x]
Brachypodius eutilotus (Jardine & Selby, 1837)	Puff-backed Bulbul
Pycnonotus plumosus Blyth, 1845	Olive-winged Bulbul
Pycnonotus goiavier (Scopoli, 1786)	Yellow-vented Bulbul
Pycnonotus simplex Lesson, 1839	Cream-vented Bulbul

Species	Common Name
Pycnonotus brunneus Blyth, 1845	Red-eyed Bulbul
Rubigula erythropthalmatus (Hume, 1878)	Spectacled Bulbul
Tricholestes criniger (Blyth, 1845)	Hairy-backed Bulbul
Alophoixus phaeocephalus (Hartlaub, 1844)	Yellow-bellied Bulbul
Iole crypta Oberholser, 1918	Buff-vented Bulbul[x]
Alophoixus bres (Lesson, 1832)	Grey-cheeked Bulbul
PHYLLOSCOPIDAE	
Phylloscopus borealis (Blasius, 1858)	Arctic Warbler
PELLORNEIDAE	
Pellorneum capistratum (Temminck, 1823)	Black-capped Babbler
Trichastoma malaccense (Hartlaub, 1844)	Short-tailed Babbler
Trichastoma sepiarium (Horsfield, 1821)	Horsfield's Babbler
Trichastoma rostratum (Blyth, 1842)	White-chested Babbler
Trichastoma bicolor (Lesson, 1839)	Ferruginous Babbler
Malacopteron magnirostre (Moore, 1854)	Moustached Babbler
Malacopteron affine (Blyth, 1842)	Sooty-capped Babbler
Malacopteron magnum Eyton, 1839	Rufous-crowned Babbler
Malacopteron cinereum Eyton, 1839	Scaly-crowned Babbler
TIMALIIDAE	
Stachyris poliocephala (Temminck, 1836)	Grey-headed Babbler
Stachyris leucotis (Strickland, 1848)	White-necked Babbler
Stachyris maculata (Temminck, 1836)	Chesnut-rumped Babbler[x]
Stachyris nigricollis (Temminck, 1836)	Black-throated Babbler
Cyanoderma erythroptera (Blyth, 1842)	Chestnut-winged Babbler
Pomatorhinus montanus Horsfield, 1821	Chestnut-backed Scimitar Babbler
Mixornis bornensis montaunus (Bonaparte, 1850)	Bold-striped Tit-Babbler
Macronous ptilosus Jardine & Selby, 1835	Fluffy-backed Tit Babbler
ZOSTEROPIDAE	
Yuhina everetti (Sharpe, 1887)	Chestnut-crested Yuhina#[x]
STURNIDAE	
Gracula religiosa Linnaeus, 1758	Hill Myna*
Aplonis panayensis (Scopoli, 1786)	Asian Glossy Starling
TURDIDAE	
Larvivora cyane (Pallas, 1776)	Siberian Blue Robin[x]
Copsychus saularis musicus (Linnaeus, 1758)	Oriental Magpie Robin
Copsychus malabaricus (Scopoli, 1788)	White-rumped Shama*

Species	Common Name
Enicurus ruficapillus Temminck, 1823	Chestnut-naped Forktail
MUSCICAPIDAE	
Rhinomyias umbratilis (Strickland, 1849)	Grey-chested Jungle Flycatcher[x]
Rhinomyias brunneatus (Slater, 1897)	Brown-chested jungle flycatcher[x]
Ficedula zanthopygia (Hay, 1845)	Yellow-rumped Flycatcher[x]
Ficedula hyperythra (Blyth, 1843)	Snowy-browed Flycatcher
Ficedula dumetoria (Wallace, 1864)	Rufous-chested Flycatcher[x]
Ficedula westermanni (Sharpe, 1888)	Little pied Flycatcher[x]
Cyornis concretus (Müller, 1835)	Dark Blue Flycatcher[x]
Cyornis banyumas Harington, 1908	Hill Blue Flycatcher
Cyornis superbus Stresemann, 1925	Bornean Blue Flycatcher#
Cyornis turcosus Brüggemann, 1877	Malaysian Blue Flycatcher
Ficedula hodgsoni (Moore, 1854)	Pygmy Blue Flycatcher[x]
MONARCHIDAE	
Terpsiphone paradisi (Linnaeus, 1758)	Asian Paradise-Flycatcher*
Hypothymis azurea (Boddaert, 1783)	Black-naped Monarch
Philentoma pyrhoptera (Temminck, 1836)	Rufous-winged Philentoma
RHIPIDURIDAE	
Rhipidura perlata Müller, 1843	Spotted Fantail
Rhipidura javanica (Sparrman, 1788)	Pied Fantail
DICAEIDAE	
Dicaeum minullum (Jerdon, 1840)	Plain Flowerpecker[x]
Dicaeum trigonostigma (Scopoli, 1786)	Orange-bellied Flowerpecker
Prionochilus thoracicus (Temminck, 1836)	Scarlet-breasted Flowerpecker[x]
Prionochilus percussus (Temminck, 1826)	Crimson-breasted Flowerpecker[x]
Prionochilus xanthopygius Salvadori, 1868	Yellow-rumped Flowerpecker#[x]
Prionochilus maculatus (Temminck, 1836)	Yellow-breasted Flowerpecker
Dicaeum chrysorrheum Temminck, 1829	Yellow-vented Flowerpecker
NECTARINIIDAE	
Nectarinia jugularis (Linnaeus, 1766)	Olive-backed Sunbird
Aethopyga siparaja (Raffles, 1822)	Eastern Crimson Sunbird
Aethopyga temminckii (Müller, 1843)	Temminick's Sunbird
Hypogramma hypogrammicum (Müller, 1843)	Purple-naped Sunbird
Anthreptes simplex (Müller, 1843)	Plain Sunbird[x]
Anthreptes rhodolaemus Shelley, 1878	Red-throated Sunbird
Anthreptes malacensis (Scopoli, 1786)	Brown-throated Sunbird[x]

Species	Common Name
Chalcoparia singalensis (Gmelin, 1788)	Ruby-cheeked Sunbird
Arachnothera longirostra (Latham, 1790)	Little Spiderhunter
Arachnothera crassirostris (Reichenbach, 1854)	Thick-billed Spiderhunter
Arachnothera flavigaster (Eyton, 1839)	Spectacled Spiderhunter[x]
Arachnothera chrysogenys (Temminck, 1826)	Yellow-eared Spiderhunter[x]
Arachnothera robusta Müller & Schlegel, 1845	Long-billed Spiderhunter
Arachnothera everetti (Sharpe, 1893)	Bornean Spiderhunter#[x]
Arachnothera modesta (Horsfield, 1821)	Grey-breasted Spiderhunter
ESTRILDIDAE	
Lonchura malacca (Linnaeus, 1766)	Black-headed Munia
Lochura leucogastra (Blyth, 1846)	White-bellied Munia
Lonchura fuscans (Cassin, 1852)	Dusky Munia#
Erythrura prasina (Sparrman, 1788)	Pin-tailed Parrotfinch[x]

BATS

Pang Sing Tyan, Khatijah Ismail, Attiqqah Fadziliah Sapian, Rahah Mohd. Yakup, Mohd. Hasri Al-Hafiz Haba, Isa Sait* and *Andrew Alek Tuen

Bats have been infamously linked with zoonotic diseases like the Nipah virus in 1999 and the current coronavirus outbreak first detected in Wuhan China in December 2019. What is less known is their huge ecological and socio-economic impact on human society. Many fruit-bats including the flying fox (*Pteropus vampyrus*) are particularly effective in pollinating durian flowers whose nectar they feed on. White durian flowers open in the early evening, their visibility and strong smell attract bats even in poor light. As bats swing below branches from one flower to another, pollens stick to their faces, and as they move, they pollinate other flowers, thus effecting pollination. Simply put, no flying foxes, less or no durian. Fruit bats also help disperse seeds of fruits that they eat, make them valuable in forest regeneration. However, some bats forage on the fruits of tress planted by humans, which has resulted in them being regarded as pests and led locals to hunt them as a food source. Insectivorous bats, on the other hand, are indispensable in controlling the population of insects. Flying foxes and some smaller fruit bats are threatened by hunting and habitat loss. Loss of habitats and overharvesting have caused significant declines in the number of bats in the wild. Under the Sarawak Wildlife Protection Ordinance, 1998, all bat species in the state are protected.

Bat surveys were carried out from December 2015 to November 2016, at 10 multiple forested sites occupied by agroforests, logged-over forests, secondary forests, primary forests within the Pelagus region, including within the Pelagus National Park. To sample the fauna, we used eight stacked mist-nets set in the understorey from the ground to 3.6 m above ground and two four-bank harp tarps. Both nets and traps were deployed in the forest areas which were thought as potential bat flyways.

Altogether, 29 species (excluding four insectivorous bats which could not be identified to species level), from seven bat families, were recorded in the Pelagus area. Seven species were fruit bats and at least 21 were insectivorous bats. Fruit bats are abundant in Pelagus based on the total 666 individuals captured. Insectivorous bats are more diverse but seemed to occur in lower numbers.

The greatest number of fruit bats were recorded in December 2015 and January 2016, with less in 2016's following months. This could be attributed to more fruiting trees in areas adjacent to where the nets and traps were deployed. For insectivorous bats, the number of individuals was the same year-round, and we assume that this is due to the year round availability of their food source in Pelagus.

The most common frugivorous species encountered was *Cynopterus brachyotis,* with a total of 517 individuals caught, followed by *Balionyteris maculata,* with 104 individuals recorded. As for insectivorous bats, *Rhinolophus trifoliatus* was the species captured the most with 24 individuals caught, followed by *Hipposideros ridleyi* with a record of nine individuals.

Nine species of insect bats were represented by a single captured individual throughout the survey. They are *Rhinolophus luctus*, *Hipposideros diaderma*, *H. galeritus*, *Kerivoula minuta*, *Pipistrellus ceylonicus*, *Tylonyteris pachypus*, and the following four that could not be identified to the species level, *Rhinolophus* sp., *Hipposideros* sp., *Pipistrellus* sp. and *Myotis* sp. The low record of these species could be due to their known efficient sonar detection of barriers in their flyways and their ability to quickly chew their way out of the mist net when caught. With echolocation, they can fly over and under the mist nets and and avoid the harp traps.

Twelve bat species were recorded in Pelagus National Park, while 28 were caught in the surrounding forests, behind the longhouses. Four species, *Dyacopterus spadieus*, *Emballonura alectro*, *Hipposideros dyacorum* and *H. ater,* were only recorded in the Park. Twelve species recorded in the forests belonging to the local community were not encountered in the Park. These bats were *Megarops ecaudatus*, *Eonycteris spelaea*, *Rhinolophus borneensis*, *R. luctus*, *R.* sp., *Nycteris javanica*, *Megaderma spasma*, *Hipposideros diaderma*, *H. galeritus*, *H.* sp., *Kerivoula minuta*, *K. pellucida*, *K.* sp. and *Myotis* sp.

With more sampling and use of additional methods (such as bat detectors, canopy nets, etc.), the list of bats for the Pelagus region could be expanded. Based on this study, community forests are essential in supporting populations of bats in the Pelagus region.

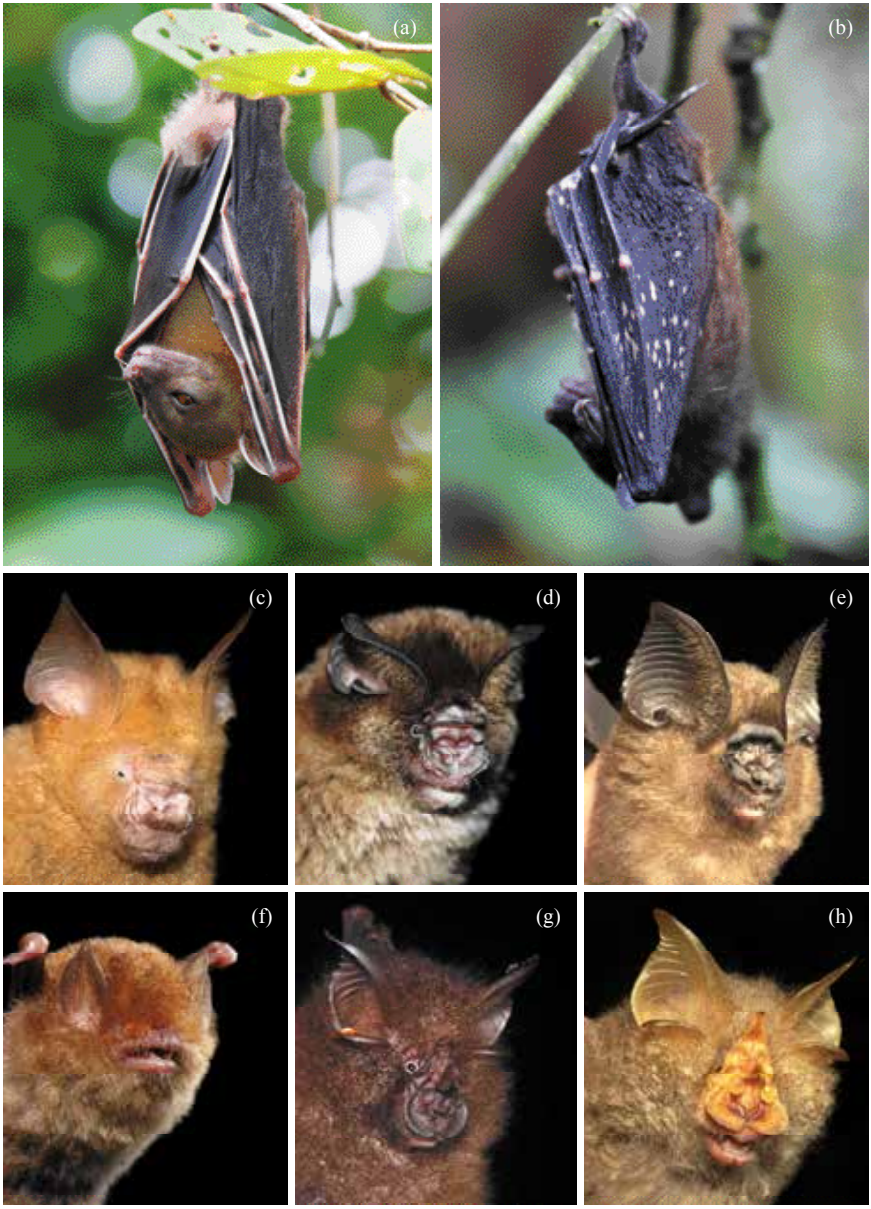


Fig. 1. (a) *Cynopterus brachyotis*; (b) *Balionycteris maculata*; (c) *Hipposideros diadema*; (d) *Hipposideros galeritus*; (e) *Hipposideros ridleyi*; (f) *Kerivoula minuta*; (g) *Rhinolophus luctus*; (h) *Rhinolophus trifoliatus*.

Fig. 2. *Tylonycteris pachypus*.

A Checklist of Bats

Species	Common Name
PTEROPODIDAE	
Cynopterus brachyotis (Müller, 1838)	Lesser Short-nosed Fruit Bat
Megarops ecaudatus (Temminck, 1837)	Temminck's Tailless Fruit Bat
Dyacopterus spadiceus (Thomas, 1890)	Dayak Fruit Bat
Balionyteris maculata Thomas, 1893	Spotted-winged Fruit Bat
Eonycteris spelaea (Dobson, 1871)	Cave Nectar Bat
Macroglossus minimus (É. Geoffroy, 1810)	Long-tongued Nectar Bat
EMBALLONURIDAE	
Emballonura alecto (Eydoux and Gervais, 1836)	Greater Sheath-tailed Bat
MEGADERMATIDAE	
Megaderma spasma (Linnaeus, 1758)	Lesser False Vampire Bat
NYCTERIDAE	
Nycteris tragata Andersen, 1912	Malayan Slit-faced Bat
RHINOLOPHIDAE	
Rhinolophus borneensis Peters, 1861	Bornean Horseshoe Bat
Rhinolophus luctus Temminck, 1834	Great Woolly Horseshoe Bat
Rhinolophus trifoliatus Temminck, 1834	Trefoil Horseshoe Bat
Rhinolophus sedulus Andersen, 1905	Lesser Woolly Horseshoe Bat
Rhinolophus sp.	Horseshoe Bat (unidentified)
HIPPOSIDERIDAE	
Hipposideros ater Templeton, 1848	Dusky Leaf-nosed Bat
Hipposideros dyacorum Thomas, 1902	Dayak Roundleaf Bat
Hipposideros ridleyi Robinson & Kloss, 1911	Ridley's Roundleaf Bat
Hipposideros cervinus (Gould, 1854)	Fawn Roundleaf Bat
Hipposideros galeritus Cantor, 1846	Cantor's Roundleaf Bat
Hipposideros diaderma (É. Geoffroy, 1813)	Diadem Roundleaf Bat
Hipposideros sp.	Roundleaf Bat (unidentified)
VESPERTILIONIDAE	
Pipistrellus tenuis (Temminck, 1840)	Least Pipistrelle
Pipistrellus ceylonicus Kelaart, 1852	Dark Brown Pipistrelle
Glischropus tylopus Dobson, 1875	Thick-thumbed Bat
Tylonyteris robustula Thomas, 1915	Greater Bamboo Bat
Tylonyteris pachypus (Temminck, 1840)	Lesser Bamboo Bat

Species	Common Name
Kerivoula papilosa Temminck, 1840	Papillose Woolly Bat
Kerivoula pellucida (Waterhouse, 1845)	Clear-winged Woolly Bat
Kerivoula intermedia Hill & Francis, 1984	Small Woolly Bat
Kerivoula minuta Miller, 1898	Lesser Woolly Bat
Kerivoula sp.	Woolly Bat (unidentified)
Myotis sp.	Myotis (unidentified)

TERRESTRIAL MAMMALS

Jayasilan Mohd-Azlan, Melynda Cheok Ka Yi, Thaqifah Syaza Jailan, Nurul Asna Hidayah Mior Abdul Rahman* and *Andrew Alek Tuen

Information on the distribution and habitat needs is critical in formulating conservation recommendations. Lack of information on microhabitat requirements for many Bornean species impedes conservation action, especially for species of conservation importance. This study focused on the distribution and activity patterns of terrestrial mammals in the interior of Sarawak. The terrestrial mammals of Borneo include 288 species, of which 102 and 61 species are dominated by bats and rodents, respectively. Large and mid-sized mammals are generally thought to be charismatic and provide economic opportunities or are of conservation concern, although some are considered as nuisance. Mammals respond differently to habitat alterations, with some being more sensitive than others. Since they form important

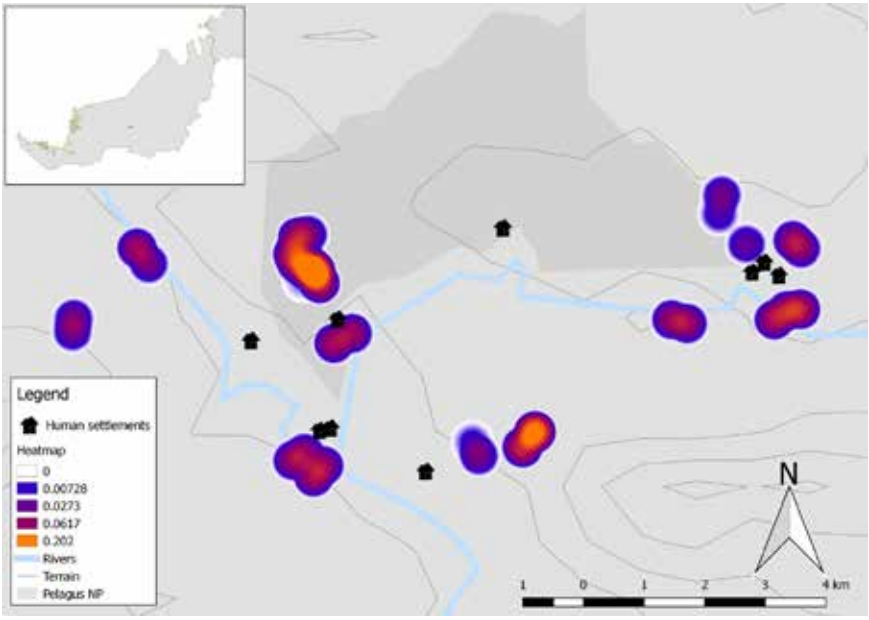


Fig. 1. Heat map showing mammal species richness within and outside Pelagus National Park, Sarawak. Areas with darker shade indicate more species detection compared to surrounding areas.

Fig. 2. (a) Marbled Cat; (b) Bay Cat; (c) Banded Palm Civet; (d) Pig-Tailed Macaque; (e) Bornean Red Munjac; (f) Malay Weasel; (g) Bearded Pig; (h) Malay Civet.

components of terrestrial ecosystems, the group can be affected by hunting, and/or loss and alteration of habitats.

A comprehensive camera trapping survey was conducted in the Pelagus area. The study area is located along the Rajang River, which is approximately a two-hour express boat ride from Kapit town. Iban longhouses dominate the area, and the sole mode of transportation is via the river. The Pelagus National Park (centred around the erstwhile Pelagus Regency Resort) covers remnant lowland forests with an expanse of secondary forests, especially in the vicinity of tribal longhouses. Some hunting activity and collection of natural resources, such as rattan, medicinal plants and timber, have been recorded here. The Park is dominated by mixed dipterocap forests, with some areas last logged in the 1960s. Dominant vegetation includes important fruiting and economically important timber trees (e.g., *Baccaurea* sp., *Artocarpus* sp., *Koompassia malaccencis*, *Koompassia excelsea*, *Shorea* sp., *Syzygium* sp., *Xanthophyllum* sp., *Ficus* sp.). On the other hand, the forests surrounding the longhouses are mostly planted with crops up to one kilometre radius. Agricultural activities in the area include rice cultivation, and planting of vegetable (e.g., *Sauropus androgynous*) and fruit bearing trees (e.g., *Artocarpus* spp. *Durio* spp., *Canarium odontophyllum*).

We used Camera Traps (Bushnell® Trophy Cam), and marked them with GPS (Garmin GPSMAP® 64s). Base camps were set up in the villages nearest to the field sites, and local field assistants were hired as guides in the deployment of camera traps.

This study was focused on mid-sized to large mammals (body over a kilo as adults). A total of 34 camera traps were deployed over a sampling period of 11 months throughout 2014 and 2015, yielding 6,782 independent photographs from 5,501 camera trap days. Independent events are defined as consecutive photographs of different species and consecutive photographs of individuals of the same species taken one hour apart. Of the 46 identifiable species, 30 are mammals which mainly consist of 17 species from the order Carnivora. Three out of the five known species of Bornean wildcats were photographed during the survey, including the 1998 Sarawak Wild Life Protection Ordinance's Totally Protected *Catopuma badia*, *Pardofelis marmorata*, and the Protected *Prionailurus bengalensis*. Species richness in Pelagus (30 species, 5501 days, 45 sites) is higher than in other protected areas (such as Maludam National Park, 11 species; Loagan Bunut National Park, 10 species; Lambir Hills National Park, 13 species; Kubah National Park; Lanjak Entimau Wildlife Sanctuary, 21 species) and non-protected areas (i.e., mixed-used planted forest, 25 species; planted forest zone, 27 species). However, we do note that sampling effort, habitat type and camera traps used

in these studies are not always comparable, and have the potential to influence the number of detections.

Of the 30 mammalian species identified, 28 were detected within and outside the Pelagus National Park. The elusive Bay Cat (*Catopuma badia*) and Banded Linsang (*Prionodon linsang*) were found exclusively in the National Park area, while otters and the Malay Weasel (*Mustela nudipes*) were only detected outside of the Park. At least 13 species of conservation importance within this group of mammals were recorded within the Park are in the IUCN Red List, while 12 other species were recorded outside the Park (Table 1). This suggests that neighbouring pristine habitats near Pelagus National Park may harbour species of conservation importance. Such species-rich unprotected areas need to be brought into the protected areas system.

A Checklist of Terrestrial Mammals

Summary of mammals recorded via camera traps from Pelagus from May 2014 to April 2015. IUCN: International Union for Conservation of Nature; CR: Critically Endangered; EN: Endangered; NT: Near Threatened; VU: Vulnerable; LC: Least Concern; SWLPO: Sarawak Wild Life Protection Ordinance 1998; TP: Totally Protected species; P: Protected species; CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora; I: Appendix I; II: Appendix II; III: Appendix III (India); NL: Not Listed.

Order	Family	Species	Common name	IUCN	SWLPO	CITES (Appendix)
Carnivora	Felidae	*Catopuma badia* (Gray, 1874)	Bay Cat	EN	TP	II
		Pardofelis marmorata (Martin, 1837)	Marbled Cat	NT	TP	I
		Prionailurus bengalensis (Kerr, 1792)	Leopard Cat	LC	P	II
	Ursidae	*Helarctos malayanus* (Raffles, 1821)	Sun Bear	VU	P	I
	Viverridae	*Arctictis binturong* (Raffles, 1821)	Binturong/ Bearcat	VU	P	III (India)
		Arctogalidia trivirgata (Gray, 1832)	Small-toothed Palm Civet	LC	P	NL
		Hemigalus derbyanus (Gray, 1837)	Banded Palm Civet	NT	P	II
		Paguma larvata (C.E.H. Smith, 1827)	Masked Palm Civet	LC	P	III (India)
		Paradoxurus hermaphroditus (Pallas, 1777)	Common Palm Civet	LC	P	III (India)
		Viverra tangalunga (Gray, 1832)	Malay Civet/ Tangalung	LC	P	NL
	Herpestidae	*Herpestes brachyurus* (Gray, 1837)	Short-tailed Mongoose	NT	P	NL
		Herpestes semitorquatus (Gray, 1846)	Collared Mongoose	NT	P	NL
	Mustelidae	*Martes flavigula* (Boddaert, 1785)	Yellow-throated Marten	LC	NL	III (India)
		Mustela nudipes (Desmarest, 1822)	Malay Weasel	LC	NL	NL
		Aonyx or *Lutra* sp.	Otter	EN/VU/NT	P	II

Order	Family	Species	Common name	IUCN	SWLPO	CITES (Appendix)
	Prionodontidae	*Prionodon linsang* (Hardwicke, 1821)	Banded Linsang	LC	NL	II
	Canidae	*Canis familiaris* Linnaeus, 1758	Common Dog			
Artiodactyla	Tragulidae	*Tragulus kanchil* (Raffles, 1821)	Lesser Mouse-deer	LC	NL	NL
		Tragulus napu (F. Cuvier, 1822)	Greater Mouse-deer	LC	NL	NL
	Cervidae	*Muntiacus atherodes* (Groves & Grubb, 1982)	Bornean Yellow Muntjac	NT	NL	NL
		Muntiacus muntjak (Zimmermann, 1780)	Common Barking Deer	LC	NL	NL
		Rusa unicolor (Kerr, 1792)	Sambar Deer	VU	NL	NL
	Suidae	*Sus barbatus* (Müller, 1838)	Bearded Pig	VU	NL	NL
Rodentia	Hystricidae	*Hystrix brachyura* (Linnaeus, 1758)	Common Porcupine	LC	P	NL
		Hystrix crassispinis (Günther, 1877)	Thick-spined Porcupine	LC	P	NL
		Trichys fasciculata (Shaw, 1801)	Long-tailed Porcupine	LC	P	NL
	Sciuridae	*Rheithrosciurus macrotis* (Gray, 1856)	Tufted Ground Squirrel	VU	TP	NL
Primates	Cercopithecidae	*Macaca fascicularis* (Raffles, 1821)	Long-tailed Macaque	LC	P	II
		Macaca nemestrina (Linnaeus, 1766)	Pig-tailed Macaque	VU	P	II
Pholidota	Manidae	*Manis javanica* (Desmarest, 1822)	Sunda Pangolin	CR	P	I

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